DEPARTMENT OF NATURAL RESOURCES

Minnow Importation Risk Report:

Assessing the risk of importing golden shiners into Minnesota from Arkansas

As required by Laws of Minnesota 2017, chapter 93, article 2, section 162

Prepared by Jeffrey Gunderson under contract to the
Minnesota Department of Natural Resources

02/14/2018

Report to the Minnesota Legislature

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As requested by Minnesota Statutes 2017, section 3.197: This report cost approximately $46,270.50 to prepare, including staff time, printing and mailing expenses.

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DEPARTMENT OF NATURAL RESOURCES

February 14, 2018

Senator Bill Ingebrigtsen, Chair
Environment and Natural Resources Finance Committee

Senator Carrie Ruud, Chair
Environment and Natural Resources Policy and Legacy Finance Committee

Representative Dan Fabian, Chair
Environment and Natural Resources Policy and Finance Committee

Dear Chairs:

Please find attached *Minnow Importation Risk Report: Assessing the risk of importing golden shiners into Minnesota from Arkansas*, as required by the Laws of Minnesota 2017, chapter 93, article 2, section 162.

This report was commissioned to analyze the risk of pathogens and invasive species that could be introduced to Minnesota via golden shiners imported from Arkansas. The report identifies key vulnerabilities and risks associated with importing golden shiners and suggests procedures to protect Minnesota's waters from invasive species and fish disease introduction.

The report includes information on several key areas:

- Golden shiner minnows imported from Arkansas cannot be considered "pathogen-free" or "invasive-species-free."
- The Arkansas bait certification does not mitigate all risks. The report identified five organisms as having higher risk of introduction, establishment and/or negative impacts.
- Ensuring chain of custody from certified farms in Arkansas to retail outlets in Minnesota is a concern.

The report also identifies procedures to reduce the risk to Minnesota's waters from unwanted species and pathogens. These include:

- Offloading golden shiner minnows into a Minnesota holding facility for additional grading, observation, and hand-removal of unwanted species.
- Testing for specific pathogens – especially those not certified by the Arkansas program – while holding in Minnesota prior to distribution.
- Developing and implementing Hazard Analysis and Critical Control Point plans, which may provide a system for identifying steps in the culture, harvest and transport of golden shiners where invasive species or pathogen hazards could be introduced and specifying measures to mitigate those hazards.

The state of Minnesota and bait retailers in the state would be responsible for bearing the costs associated with developing and implementing these procedures.

Minnesota is recognized as a leader regionally and nationally for our robust regulatory system to prevent the introduction and spread of invasive species. Prevention policies are more cost-effective and offer greater ecological benefits than attempting to control the spread of species that do arrive in the state. Regulating pathways of potential expansion is the best way to reduce the risk of introduction or spread of aquatic invasive species because those regulations are simple to follow and to enforce.

Given the risks and costs identified in the report, the Department of Natural Resources recommends not allowing the importation of golden shiners from Arkansas.

If you have any questions about this report, please contact Bob Meier, Assistant Commissioner for Legislative Affairs, at bob.meier@state.mn.us or 651-259-5024.

Sincerely,

Tom Landwehr
Commissioner

Cc: Senator David Tomassoni
Senator Chris Eaton
Representative Rick Hansen
Committee Administrators
Legislative Reference Library

DEPARTMENT OF NATURAL RESOURCES

Executive Summary

Prepared by the Minnesota Department of Natural Resources

The Minnesota Department of Natural Resources (DNR) issued a request for proposals (RFP) to produce the report and awarded the contract to Jeffrey Gunderson. Mr. Gunderson worked for the University of Minnesota Sea Grant program for 36 years prior to retiring as its director in 2015. Mr. Gunderson was certified as a Seafood Safety Hazard Analysis and Critical Control Point (HACCP) trainer by the National Seafood HACCP Alliance and trained commercial fishermen and fish processors to evaluate seafood safety risks and develop HACCP plans. He helped lead the effort to apply the Seafood HACCP concept to reduce the risk of moving aquatic invasive species (AIS) via baitfish and farmed fish, creating AIS-HACCP.

Mr. Gunderson and the DNR coordinated with the University of Minnesota throughout the process. In particular, the DNR worked with risk assessment process experts Dr. Rob Venette, Dr. Kristen Nelson, and Dr. David Andow to scope the RFP. The DNR also identified Dr. Nick Phelps as an expert in fish pathogens for Mr. Gunderson to interview. All four of these University of Minnesota faculty were invited to participate in check-in calls, and review drafts of the report (see Appendix K for more description of the process).

This minnow importation risk report provides information for decision making

This report provides analysis sufficient to identify vulnerabilities and risks associated with importing golden shiners into Minnesota from Arkansas. Mr. Gunderson reviewed available literature and interviewed experts in Arkansas and other states to evaluate the risk of 33 pathogens and invasive species that could come to Minnesota via golden shiners imported from Arkansas. Through this risk screening process, Mr. Gunderson identified five species that are relatively higher risk even with the Arkansas bait certification program in place. However, the risk of importing any of the 33 organisms with golden shiners from Arkansas would be higher than it is now because the minnow import pathway is currently illegal. Any change to the current policy of banning imported, live minnows, including allowing import of golden shiners from Arkansas, would require the State of Minnesota to increase spending on development, implementation, training, and enforcement of risk management activities associated with this currently illegal pathway of minnow import.

Importing golden shiner minnows will increase the risk of unwanted pathogens and invasive species being introduced to Minnesota

It is currently illegal to import any live minnows into the State of Minnesota. Any change to the current prohibition on minnow import will increase the risk that new aquatic invasive species or pathogens will be introduced by that currently prohibited pathway. The DNR is concerned about exposing the state to increased risk of introduction of any species.

In particular, the report identified that the risk of importing one organism, ovarian parasite, in golden shiners from Arkansas is high. There are no known methods to mitigate the risk of ovarian parasite, which can render infected golden shiners unable to reproduce. Specific surveillance efforts have identified ovarian parasite in bait shops in Minnesota but we have not confirmed it in wild golden shiner populations in Minnesota.

The report also includes information on several key areas:

- Golden shiner minnows imported from Arkansas cannot be considered "pathogen-free" or "invasive-species-free". Some invasive species of great concern in Minnesota, such as black carp and grass carp, are not certified by Arkansas's program.
- The Arkansas bait certification does not mitigate for all risks. The report identified five organisms as higher priority for their risks of introduction, establishment and/or impacts: Asian tapeworm, ovarian parasite, golden shiner virus, Western mosquitofish and nonnative crayfish.
- Concerns about ensuring chain of custody from certified farms in Arkansas to retail in Minnesota were identified by DNR enforcement as well as by officials from other states importing minnows.

Importing golden shiners will cost the State of Minnesota

Importing golden shiners from Arkansas will increase costs to Minnesota through additional risk management, prevention, outreach and enforcement needs.

DNR enforcement and Vermont, a state that allows minnows to be imported from Arkansas, expressed concerns about the chain of custody for golden shiners. Without a verifiable chain of custody it is impossible to determine if the golden shiners that are offloaded in Minnesota actually originated on a certified farm. The report offers several ideas for strengthening the chain of custody:

- Sealing certified minnow compartments.
- Using GPS tracking devices to ensure proper transport.
- Developing and using computerized and standard certification, load layout, and manifest forms.

The report identifies procedures that we could take to reduce the risk to Minnesota's waters from unwanted species and pathogens associated with imported minnows. These include:

- Offloading golden shiner minnows into a Minnesota holding facility for additional grading, observation, and hand removal of unwanted species.
- Testing for specific pathogens – especially those that are not certified by the Arkansas program - while holding in Minnesota prior to distribution.
- Developing and implementing Hazard Analysis and Critical Control Point (HACCP) plans.
- Work with MN DNR enforcement, wholesalers, transporters, and retailers to develop standardized protocols for chain of custody.

Mr. Gunderson also suggests an alternative solution: invest in increasing production within the state of Minnesota. The report identifies indoor culture, obtaining golden shiner fry earlier, and increasing pond availability as potential ways to boost Minnesota production. Such alternatives would maintain the current level of protection against pathogens and invasive species from the minnow import pathway and invest in Minnesota's own industry.

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Introduction

Legislation was proposed in both the Senate and House in 2017 to allow the importation of golden shiners from certified baitfish farmers in Arkansas. That legislation did not pass, but the Minnesota Department of Natural Resources (MN DNR) was required to submit this report to the legislature by the Laws of Minnesota 2017, chapter 93, article 2, section 162:

> MINNOW IMPORTATION RISK REPORT.
>
> By January 15, 2018, the commissioner of natural resources must report to the chairs of the legislative committees with jurisdiction over natural resources regarding potential risks of importing golden shiner minnows into Minnesota. The commissioner of natural resources must coordinate with the University of Minnesota and may use a third party to produce the report. The report must:
>
> > (1) review the Arkansas bait certification program to determine specific risks and potential mitigation measures of allowing the importation of golden shiner minnows by a person that holds a Minnesota wholesale minnow dealers license issued under Minnesota Statutes, section 97C.501, subdivision 2; and
> >
> > (2) include recommendations on testing protocols or procedures needed to protect Minnesota's waters from invasive species and fish disease introduction.

The MN DNR requested additional information be included in the report in the Request for Proposals for this report. As a result, this report has seven main components.

1. A review of golden shiner production in Arkansas
2. A review of the Arkansas commercial bait and ornamental fish certification program
3. A review of aquatic invasive species in Arkansas
4. An assessment of the risks associated with importing golden shiners from Arkansas
5. Identification of mitigation protocols for moderate to high risk species
6. Personal communication regarding golden shiner importation
7. Identification of future steps, studies, analyses that would help decision making

The majority of this report will focus on the risk assessment. The MN DNR identified several diseases, parasites, non-native fish, and other organisms of concern in the request for proposals. During the course of this project, several more organisms were added to assess as potential risks. All organisms of concern are identified in a matrix (APPENDIX A) that assesses the risks posed by each by examining the following criteria:

1. Is the organism of concern certified by the AR certification program?
2. What is the distribution of the organism in AR?
3. What is the distribution of the organism in MN?
4. What is the likelihood the organism would be transferred with golden shiners?
5. What is the likelihood the organism will become established in MN if introduced into waters of the state?
6. What would the impact be if established?
7. What is the likelihood the organism could enter waters of the state via another pathway?

A written justification for each of the seven risk assessment criteria for all 33 organisms of concern was developed. Expert opinion and review of the literature was used to make these determinations. Organisms that were deemed to present a moderate to significant risk based on these criteria were selected for further review and recommendations.

Given the short amount of time available and the number of organisms included in this report, it was not possible to develop true risk assessments for each organism. Answering the seven questions above was based on easily accessible information and was done to select the organisms that presented the greatest risk for importation of golden shiners into Minnesota. There was no attempt to provide qualitative uncertainty ratings (Risk Assessment and Management Committee, 1996) for the risk levels provided in this report. While relying on information in the literature and expert opinion, the ultimate risk rankings were made using my best judgement.

Golden Shiner Production in Arkansas

Background

According to the 2013 USDA Aquaculture Census, the nation produced baitfish worth $29.4 million. Of that total, Arkansas led the nation with $18.4 million in baitfish aquaculture sales. The next closest state was Minnesota with $2.4 million in total baitfish sales (USDA 2013). Even though the value of baitfish produced in Arkansas was over 7.5 times larger than Minnesota, there were far more surface acres used for baitfish production used in Minnesota (nearly 16,000 acres) than were reported in Arkansas (nearly 13,000 acres). Golden shiners were the most important baitfish produced nationally ($14.3 million in total sales and over 6 million pounds), and Arkansas contributed the most of any other state with $10.6 million in sales (USDA 2013). Minnesota only reported $175,000 in golden shiners sales in the 2013 census which was less than half of the $471,000 reported in the 2005 census (USDA 2013).

Golden shiners are the most significant component of U.S. baitfish aquaculture (by sales value) because they are a favored bait among anglers and they have several characteristics which make them a good aquaculture species. They have an expansive native range which includes areas east of the Rocky Mountains from Nova Scotia and Hudson Bay to Florida and Texas. They are considered a warm water

species but they have a broad temperature tolerance. They are a schooling fish that consume a wide variety of foods from phytoplankton and zooplankton to formulated fish feeds. Golden shiners are considered fecund and their broadcast spawning behavior and adhesive eggs adapt well to pond culture. Their peak spawning occurs at temperatures from 20-24 C (68-75 F) and their optimum temperature for growth is around 24 C (75 F). Their growth rate allows them to reach market size quickly where temperatures and growing season are optimal. Unfortunately, the Minnesota climate is not conducive to producing market size fish outdoors in one growing season.

Baitfish aquaculture started in Arkansas in the late 1940s and there is one account that suggests the original stock of golden shiners used to develop the aquaculture industry was brought to Arkansas from Minnesota. The superintendent of the state hatchery brought golden shiners in from Minnesota as bass forage and provided some to one of the pioneering fish farmers near Lonoke. That fish farmer is quoted as saying “That species has made the industry as viable as it is today, and the industry would not be here today if it had not been for Hogan (the Lonoke hatchery manager that brought golden shiners into the state) (Stone et al. 2016).

Production Cycle

Box 1, adapted from Table 4 in Stone et al. (2016) provides an overview of the annual production cycle. The following is a summary of the production cycle as described by Stone et al. (2016).

The production cycle begins in the spring as water temperatures increase and spawning begins. Peak spawning is typically at water temperatures of 20-24 C (68-75F) and during the month of May, however, it depends on weather and can be as early as April or as late as June. Latex coated coconut fiber spawning mats (53 x 76 cm or 20 x 30 in) are placed on floating racks in grow-out ponds near the shore with 2-2.5 cm (1 in) of water over them. Only one-year-old brood fish are used because they have a lower incidence of the ovarian parasite which can cause sterility in older females (Stone et al. 2016). Golden shiners are fractional spawners, releasing 200–500-eggs at numerous times throughout the spawning season. Golden shiner eggs are adhesive and stick to the mats. Spawning activity is monitored and the mats are collected after about 12 hours or when it looks like sufficient egg deposition has occurred. Farmers prefer to have 100,000 to 150,000 eggs on each mat. Mats are transported to indoor hatcheries where the mats are placed in tanks and suspended above the bottom. The 18 C (65 F) well water is heated 5 to 6 C (8 to 10 F) for egg incubation (Stone et al. 2008). Eggs are usually treated with formalin until they get to the eyed stage to prevent fungus. If there are mats with too few or too many eggs, the eggs are removed from the mats with a 1.5% solution of sodium sulfite. The loose eggs are poured into jars and incubated. Golden shiner larvae have cement glands on their heads that they use to hold onto a resting place after hatching. The adhesive from these glands makes a mess if the eggs hatch in the jars. Therefore, eggs are poured into tanks with mats prior to hatching. Eggs typically hatch in 3 days and larvae then cling to mat surfaces for another day or two before becoming free swimming. Water levels are slowly dropped in each tank until free swimming fry are concentrated; then water and fry are drained into shallow tubs. Fry numbers are estimated and the fry are placed in plastic bags with water and oxygen for transfer to nursery ponds on that farm. Fry are slowly acclimated to the pond water temperature before stocking.

Prior to spawning, nursery ponds are drained to ensure no unwanted species are in the ponds and to minimize the presence of predacious insects and copepods. Nursery ponds are partially filled with ground water and then filled with water from established golden shiner ponds (that have previously

been filled with ground water). Nursery ponds are only partially filled at the time of stocking. They are usually 2-4 ha (5-10 acres) and 1-2m (3-6 ft) deep. Typically, fry stocking rates are 2.5 to 7.5 million fry/ha. Nursery ponds may be fertilized and the fry are fed a finely ground feed twice per day for several weeks. Feed is changed to crumbled extruded pellet as the fish grow. Fry are raised in nursery ponds for 6-8 weeks and then are moved into grow-out ponds on the same farm where they are stocked at lower densities.

Grow-out ponds are generally stocked at a rate of 250,000 to 500,000 fish/ha, but stocking density is adjusted for the size of bait the farmer wants to market. Lower stocking densities result in larger fish. Golden shiners in grow-out ponds are fed a floating catfish feed 5-7 days/week. There is usually a 200 day growing season in Arkansas (Stone et al. 2008). Some golden shiners are kept through the winter. Feeding is reduced and not provided if weather and water temperatures are low. Trying to match size, volume, and timing of market demand is challenging for farmers. If grow-out ponds are not drained, they will have golden shiners from previous years. This is called "polysizing." Ponds may be rotated between nursery ponds and grow-out ponds. Nursery ponds are drained prior to stocking so ponds may then be drained on average every five years (Stone et al. 2008).

Once fish reach appropriate market size, they are harvested. Ponds are partially harvested each week. Sinking pellets are fed to attract fish to areas that are then seined. Fish needed for market are dip netted out of seines into buckets and loaded onto a truck filled with well water. Fish not needed for market are released back into the pond. Harvested fish are hauled to the vats in the on-site holding shed for acclimating to fresh well water, clearing their intestinal tracks, grading and transporting to market. Average yield may be around 500 kg/ha (450 lbs./acre) but yields up to 745 kg/ha (665 lbs./acre) in ponds fed a fish meal diet have been found (Stone et al. 2016).

Harvest and Transportation

Harvested golden shiners are brought to the holding shed and placed in vats. Salt is typically added at 5 ppt to help reduce osmoregulatory stress. Harvested fish are left alone for 24 hours or more as they purge food and waste products and the small amount of pond water from the bucket transfer from seine to truck is exchanged with fresh ground water. Golden shiners are then graded into several size categories by moving vertical drag graders through the vats. Graders have bars in increments of 1/64 in that separate fish by body width. For example, a #27 grader has a spacing between the parallel bars of 27/64 in. Fish with a body width greater than that will be retained. During grading smaller fish sometimes resist moving through the grader so it is not completely effective. Graded fish are moved to vats with similar sized fish. By the time fish are ready to be loaded onto trucks, they are being held in 100% ground water. Well water is added at a rate of 5 gallons/minute so that the vats typically turn over every four hours (Jamie Anderson, personal communication, 1/22/18). Fish are dip netted from the vats into buckets or larger transfer containers for loading onto trucks. Liquid oxygen is used to maintain oxygen levels in hauling tanks and 2 ppt salt (sodium chloride) is often added as an osmoregulatory stress reliever. Golden shiners are then hauled to market which may be 12 hours or more away. Vats are completely drained and cleaned before any other fish are brought in from the ponds.

Golden shiners are then typically off-loaded at another baitfish wholesaler's facility. The truck may be drained directly into holding tanks at the facility. Ground water is used in the facility. Additional grading may take place and then the golden shiners will be dip netted out of the tanks and loaded onto trucks

for distribution to retail outlets or to another wholesale operator (Dave Robinson, personal communication, 12/04/17).

Some of the golden shiners are sold in the fall once they reach market size, but the vast majority are sold the following spring as one-year-old fish. The golden shiners that are in demand for ice fishing in northern states are held until the following fall/winter. The shiners that are marketed at 4 to 6 in are therefore, approximately 1.5 years old (Dr. Eric Park, personal communication, 1/15/18).

Box 1. *Annual production cycle on a golden shiner farm in Arkansas* (From Stone et al. 2016)

Months Activities

January–March Weekly harvests of fish for sale, especially crappie minnows. Fish are fed on warm days. Bird scaring continues (for more information about bird scaring, see http://agrilife.org/fisheries/files/2013/09/SRAC-Publication-No.-401-Controlling-Bird-Predation-at-Aquaculture-Facilities-Frightening-Techniques.pdf). Preparations for spawning season are made. Future nursery ponds are harvested and drained. Spring fish health inspections must be scheduled.

April–May Spawning season is an intense period when mats with eggs are moved from brood ponds to the hatchery, and fry are stocked out into newly filling ponds. Ponds are fertilized as needed. Fish are fed daily. Weekly harvests of fish for sale continue. Bird scaring continues. Levees are mowed.

June–October Juveniles are harvested from nursery ponds and spread out at lower densities into grow-out ponds. Fish are fed daily and ponds monitored closely. Nightly aeration may be used. State Plant Board inspector checks vats and ponds for aquatic nuisance species. Weekly harvests of fish for sale continue, as does bird scaring. Levees are mowed.

November–December Harvest of fish for sale continues, and bird scaring must be continued. Fish are fed on warmer days. Pond grading may be performed to selectively harvest larger minnows. As time permits, there is the annual paperwork (permit renewals, etc.), maintenance, and planning for the next production cycle. Arrangements for fall health inspection of fish must be made.

To gain a better understanding of the scale of the farms and the production, harvesting, grading and shipping of baitfish watch this video of baitfish production in Arkansas (www.youtube.com/watch?v=amnjic-EJzg) produced in 1996 by the Southern Regional Aquaculture Center.

Review of the Arkansas Commercial Bait and Ornamental Fish Certification Program

Origin of Certification Program

Arkansas claims the title of being the birthplace of warm water aquaculture in the U.S. and has the nation's second largest aquaculture industry with $61 million in sales in 2013 (USDA Census 2013). The Arkansas aquaculture industry is also one of the most diverse in the nation; commercial fish farms raise fathead minnows, golden shiners, goldfish, catfish, largemouth bass, bluegill, redear sunfish, hybrid

striped bass, koi, grass carp, black carp and more. These species supply markets for food-fish, recreational fishing bait, fish for stocking, pets, garden supply, food for ornamental fish, and aquatic weed and snail control. Arkansas leads the nation in baitfish production and is third in catfish production. The aquaculture industry in Arkansas is worth approximately $160 million and is an important contributor to the economy of the state (www.pbcommercial.com/accent/talking-fish-state-local-officials-stress-impact-uapb-fish-lab-lonoke).

To help support this industry, the University of Arkansas at Pine Bluff developed a diagnostic laboratory approved by USDA/APHIS to inspect fish for international export in 1995. Aquaculture/Fisheries Center fish health specialists held biosecurity and fish inspection education sessions for farmers, and participation in the health inspection program gradually increased. The program got a big boost when they were able to demonstrate that an outbreak of Spring Viremia of Carp virus that occurred in 2002 at a farm in North Carolina did not come from fish they purchased from an Arkansas farm. The certification program was credited with keeping farms in business (Kelly Winningham, personal communication, 12/06/17).

When Viral Hemorrhagic Septicemia and Heterosporis were discovered in the Great Lakes region, the Arkansas aquaculture industry realized their industry was at risk (Kelly Winningham, personal communication, 12/06/17). There was an increasing recognition that baitfish could spread disease and aquatic invasive species. States began to impose stricter limits on imported live fish and some states were closing their borders to baitfish importation. Arkansas fish farmers believed Arkansas' farm-raised product offered greater safety from disease and AIS spread than wild-caught baitfish, but in order to demonstrate the safety of farm-raised baitfish they needed a way prove it.

In 2005, the Arkansas Bait and Ornamental Fish Growers Association worked with state officials to develop a voluntary, fee-based state certification program to provide "high quality, farm-raised bait and ornamental fish, free of certain diseases, undesirable plants, undesirable animals, and other contaminates deemed injurious to fish or fisheries" (Circular 21 2010). The Arkansas State Plant Board, a division of the Arkansas Agriculture Department became the official certifying agent through an act passed in 2005 (Commercial Bait and Ornamental Fish Act A.C.A. 2-5-201).

The formal Arkansas Commercial Bait and Ornamental Fish Certification Program officially began in 2007 and is described in Circular 21: Regulations on Aquaculture in Arkansas published in March, 2007.

The Arkansas Commercial Bait and Ornamental Fish Certification Program provides assurances that products from participating bait and ornamental fish farms are free of the listed pathogens, plants, animals and other contaminants. The program has been held up as a model for other state and national programs (Anita Kelly, personal communication, 12/8/17) designed to prevent the spread of fish pathogens and invasive species. The program provides for third-party verification of farm-level fish disease inspections, biosecurity plans, and farm inspections for aquatic invasive species. The 16 participating fish farms can be found at the official safe bait web site (http://safebaitfish.org/links.html).

The Arkansas Plant Board oversees the program, and its trained employees do the pond inspections for aquatic invasive species. They ensure that only well water is used for filling ponds and loading trucks and that all fish are hatched on the farm. They charge $1/ acre of water and inspect half the ponds each year.

The University of Arkansas at Pine Bluff Fish Health Inspection Laboratory does the testing for pathogens and parasites. Located in Lonoke, Arkansas, the lab is one of eleven facilities nationwide approved by the Animal and Plant Health Inspection Service (APHIS) to conduct diagnostic testing that enables producers to obtain health certification for the export of aquaculture species.

Regulations on Aquaculture in Arkansas
The following describes the program from the legal document (Circular 21).

Purpose
The purpose of the Official Standards for the Certification of Commercial Bait and Ornamental Fish in Arkansas is:

> *To provide high quality, farm-raised bait and ornamental fish, free of certain diseases, undesirable plants, undesirable animals, and other contaminants deemed injurious to fish or fisheries.*

Authority
The Arkansas State Plant Board, a division of the Arkansas Agriculture Department, under act 1449 of 2005, is the official certifying agent.

Certified Pathogens and Aquatic Nuisance Species

As stated within the Final Rule (Circular 21 2010), "Within the detection limits of the appropriate official testing protocol, commercial bait and ornamental fish meeting these standards are certified free of the pathogens, plants, animals and other contaminates listed here:"

a. Spring Viremia of Carp (SVCV)
b. Infectious Pancreatic Necrosis (IPNV)
c. Viral Hemorrhagic Septicemia (VHSV)
d. Infectious Hematopoietec Necrosis (IHNV)
e. Eurasian watermilfoil (*Myriophyllum spicatum*)
f. Giant Salvinia (*Salvinia molesta*)
g. Hydrilla (*Hydrilla verticillata*)
h. Zebra mussel (*Dreissena polymorpha*)
i. New Zealand mud snails (*Potamopyrgus antipodarum*)
j. Red-rimmed melania (*Melanoides tuberculata*)
k. Sticklebacks (Family Gasterosteidae)
l. Rudd (*Scardinius erythrophthalmus*)
m. Orfe (*Leuciscus idus*)
n. Silver carp (*Hypophthalmichthys molitrix*)
o. Bighead carp (*Hyprophthalmichthys nobilis*)
p. Snakehead fish (Family Channidae)
q. Quagga Mussel (*Dreissena rostriformis bugensis*)

Additional pathogens may be certified if requested. See Dr. Anita Kelly's comments in the Personal Communication: Comments Regarding the AR Certification Program section of this report. Some of the additional pathogens that Dr. Kelly will certify include:

- Fathead minnow nidovirus

- *Heterosporis*
- Golden shiner virus
- Asian tapeworm
- Koi herpes virus
- *Edwardsiella tard*a
- Largemouth bass virus

Controlled Species

As stated, "Commercial bait and ornamental fish meeting program standards are certified to be produced using Arkansas Plant Board approved best management practices (BMPs) that reduce the likelihood that the following species will be present in any shipment of certified fish."

a. Mosquito fish (*Gambusia* spp.)

The following are the best management practices in place that certified farms are recommended to follow (Circular 21) which reduces the risk of moving western mosquitofish with golden shiners.

BMPs relate to pond preparation:

- Ponds are drained and dried between crops
- Any water remaining after drying is treated with a suitable pond bottom sterilant or piscicide.

BMPs specifically related to golden shiner fry production:

- No uncertified broodstock can be used (an existing requirement of the Certification Program)
- Broodstock must be inspected for *Gambusia*
- Broodstock cannot be used if *Gambusia* are present
- *Gambusia*-free broodstock can be hand selected from mixed fish populations
- When fish are hatched in tanks, egg mats must be thoroughly disinfected by treatments with 50-100 ppm iodine or 500-1000 ppm formalin prior to hatch and fry transfer.

Last, biosecurity is further addressed in that all equipment (e.g., seines, nets, fish haulers) moved from production ponds to areas known or suspected with *Gambusia* must be dried or treated with a piscicide.

Eligibility Requirements

To be designated as Arkansas Certified, bait and ornamental fish must:

a) have been spawned, hatched, and reared in Arkansas on a fish farm,
b) have been raised in accordance with the practices and procedures defined in these standards,
c) have met all inspection and testing requirements defined in these standards, and
d) be accompanied by a valid Arkansas Agriculture Department certificate.

Cultural Practices and Business Procedures

Applicants for the Commercial Bait and Ornamental Fish in Arkansas program must have an Arkansas Game and Fish Commission (AGFC) Fish Farmer Permit and they must sign an affidavit agreeing to strictly follow the cultural practices and business procedures below. The following is an abbreviated description. See Circular 21 for complete description.

a) Culture only species on the Approved Aquaculture Species List (AR ANS Management Plan page 253).
b) Use only well or recycled water on the farm.

c) Stock only certified fish.
d) Uncertified portions of farm must be kept separate as defined in a Plant Board approved biosecurity plan.
e) Fish other than baitfish must be kept separate according to biosecurity plan.
f) There must be no production of salmonids or non-fish aquatic nuisance species.
g) No silver or bighead carp can be stocked into bait or ornamental fish production ponds.
h) Certified fish must be loaded on trucks using water from the producer's certified farm.
i) Certified fish must be separated from any shipments of uncertified fish or water.
j) If trucks or equipment contacted uncertified fish or water, they must be disinfected prior to entrance to a certified farm.
k) Farms will produce certified fish according to Arkansas Plant Board approved best management practices for controlled species (*Gambusia* spp.).

Inspections

Regular inspections are conducted of certified fish farms at least once per year by the Director of the State Plant Board or his agent.

Inspections examine water, levee ponds, indoor hatchery and other fish processing facilities, equipment, compliance with BMPs (including disinfection) and verification of fish sale and purchase records. Details concerning annual inspection from the Plant Board are specified with 50% of the total number of ponds inspected for snail species, zebra mussels and specific aquatic plants. All ponds are inspected at least once every two years. Pond edges, standpipes, and hard surfaces are inspected and inspectors are authorized to take samples for positive identification. Farm records are examined for evidence of commerce in listed species.

Disease Testing

Each year the certified producer must provide documentation of two consecutive years of freedom from certified pathogens from an APHIS approved laboratory.

a) The sample must be 150 fish and must include moribund fish if observed.
b) Samples must be collected twice per year – once in the spring and once in the fall.
c) Sample collection must be overseen by an APHIS accredited DVM.
d) The sample should include all ponds and grow-out tanks.
e) The species and age composition must reflect the overall composition of the certified fish on the farm.
f) For farms with more than 50 ponds, all species and sizes of fish must be included in each sample, but the ponds may be sampled in rotation so that all ponds are sampled at least once every two years.

Farms that test positive for listed certified pathogens may not label or represent their fish as certified. If one fish from one pond on an entire farm are found to have one of the certified pathogens, then fish from the whole farm cannot be certified until they are pathogen-free for two years (Dr. Eric Park, personal communication, 1/15/18). These protocols are designed to have a 98% confidence in detection.

Bait and Ornamental Fish Certificates include: an identification number, certification statement, expiration date, detailed load description, legal warnings, and watermark that make it difficult to alter or copy.

Aquatic Invasive Species in Arkansas

Invasive Species found in Arkansas

Like many states, Arkansas is battling a number of aquatic invasive species. There are also new invasive species that could arrive and cause problems. Ninety-five (95) non-native animal and plant species have been introduced into Arkansas (U.S. Geological Survey NAS 2017 accessed December, 2017). Non-native species identified by the group include: 57 freshwater fish, 25 aquatic or wetland plants, 4 crustaceans, 3 mollusks, 2 reptiles, 1 amphibian, 1 bryozoan, 1 hydrozoan and 1 mammal (Table 1). Some of the species listed in Table 1 are from a single report while others have become established in the state. These groups and numbers are relatively similar to nearby states like LA (123), MO (120), OK (108), TN (102) and MS (94), however TX (219) is an exception.

Additionally, ten fish pathogens and parasites have been found in Arkansas. Those include: infectious pancreatic necrosis virus, golden shiner virus, Asian tapeworm (*Schyzocotyle acheilognathi*), koi herpes virus, *Edwardsiella tarda*, largemouth bass virus, channel catfish virus, enteric septicemia of catfish (*Enteric ictaluri*), ovarian parasite (*Ovipleistophora ovariae*), and furunculosis (*Aeromones salmonicida*)

Table 1. Non-native Species Listed from U.S. Geological Survey Database (accessed December 21, 2017).

Non-Native Species	**Non-Native Species**
57 Freshwater Fishes	**25 Aquatic or Wetland Plants**
American shad (*Alosa sapidissima*)	Alligatorweed (*Alternanthera philoxeroides*)
Arkansas River shiner (*Notropis girardi*)	Australian water-clover (*Marsilea mutica*)
Bighead carp (*Hypophthalmichthys nobilis)*	Brazilian water-hyssop (*Bacopa egensis*)
Black carp (*Mylopharyngodon piceus*)	Brazilian waterweed (*Egeria densa*)
Black carp (*Mylopharyngodon piceus* var. *diploid*)	Brittle waternymph (*Najas minor*)
Blue tilapia (Oreochromis aureus)	Curly-leaf pondweed (*Potamogeton crispus*)
Brook trout (*Salvelinus fontinalis*)	Dioecious hydrilla (*Hydrilla verticillata*)
Brown bullhead (*Ameiurus nebulosus*)	Dotted duckweed (*Landoltia punctate*)
Brown trout (*Salmo trutta*)	Duck-lettuce (*Ottelia alismoides*)
Chain pickerel (*Esox niger*)	Eurasian watermilfoil (*Myriophyllum spicatum*)
Chub shiner (*Notropis potteri*)	Floating water hyacinth (*Eichhornia crassipes*)
Common carp (*Cyprinus carpio*)	Giant salvinia (*Salvinia molesta*)
Cutthroat trout (*Oncorhynchus clarkii*)	Large-flower primrose-willow (*Ludwigia grandiflora*)
Dollar sunfish (*Lepomis marginatus*)	Marsh dewflower (*Murdannia keisak*)
Fathead minnow (*Pimephales promelas*)	Narrow-leaved cattail (*Typha angustifolia*)
Golden shiner (*Notemigonus crysoleucas)*	Parrot feather (*Myriophyllum aquaticum*)
Goldfish (*Carassius auratus*)	Peacock spikemoss (*Selaginella uncinata*)
Grass carp (*Ctenopharyngodon idella*)	Sacred lotus (*Nelumbo nucifera*)
Ide (*Leuciscus idus*)	Single-vein sweetflag (*Acorus calamus*)
Inland silverside (*Menidia beryllina*)	Water foxtail (*Alopecurus geniculatus* var. *geniculatus*)
Lake trout (*Salvelinus namaycush*)	Water lettuce (*Pistia stratiotes*)
Muskellunge (*Esox masquinongy*)	Water spangles (*Salvinia minima*)
Nile tilapia (*Oreochromis niloticus*)	Water-cress (*Nasturtium officinale*)
Northern pike (*Esox lucius*)	Yellow floating-heart (*Nymphoides peltata*)
Northern snakehead (*Channa argus*)	Yellow iris (*Iris pseudacorus*)
Oscar (*Astronotus ocellatus*)	

Non-Native Species	Non-Native Species
Ozark bass (*Ambloplites constellatus*)	**4 Crustaceans**
Ozark shiner (*Notropis ozarcanus*)	Calanoid copepod (*Eurytemora affinis*)
Red-bellied pacu (*Piaractus brachypomus*)	Lumholtzi waterflea (*Daphnia lumholtzi*)
Pumpkinseed (*Lepomis gibbosus*)	Gap ringed crayfish (*Faxonius neglectus chaenodactylus*)
Rainbow smelt (*Osmerus mordax*)	White river crawfish (*Procambarus acutus acutus*)
Rainbow trout (*Oncorhynchus mykiss*)	
Redbelly tilapia (*Tilapia zilii*)	**3 Molluscs**
Redbreast sunfish (*Lepomis auritus*)	Asian clam (*Corbicula fluminea*)
Redear sunfish (*Lepomis microlophus*)	Common octopus (*Octopus vulgaris*)
Redeye bass (*Micropterus coosae*)	Zebra mussel (*Dreissena polymorpha*)
Rock bass (*Ambloplites rupestris*)	
Rudd (*Scardinius erythrophthalmus*)	**2 Reptiles**
Sauger (*Sander canadensis*)	Razor-backed musk turtle (*Sternotherus carinatus*)
Saugeye (*Sander canadensis x vitreus*)	Yellow anaconda (*Eunectes notaeus*)
Silver carp (*Hyophthalmichthys molitrix*)	
Slender madtom (*Noturus exilis*)	**1 Amphibian**
Smallmouth bass (*Micropterus dolomieu*)	Green treefrog (*Hyla cinerea*)
Sockeye salmon (*Oncorhynchus nerka*)	
Striped bass (*Morone saxatilis*)	**1 Bryozoan**
Tench (*Tinca tinca*)	Magificient bryozoan (*Pectinatella magnifica*)
Threadfin shad (*Dorosoma petenense*)	
Tiger muskellunge (*Esox lucius x masquinongy*)	**1 Hydrozoan**
Tiger trout (*Salmo trutta x Salvelinus fontinalis*)	Freshwater jellyfish (*Craspedacusta sowerbyi*)
Unidentied pacu (*Colossoma* or *Piaractus* sp.)	
Walleye (Sander vitreus)	**1 Mammal**
Western mosquitofish (*Gambusia affinis*)	Nutria (*Myocastor coypus*)
White bass (*Morone chrysops*)	
White catfish (*Ameiurus catus*)	
White perch (*Morone americana*)	
Wiper (*Morone chrysops x M. saxatilis*)	
Yellow perch (*Perca flavescens*)	

Summary of Arkansas Aquatic Invasive Species Plan

In response to threats of non-native species, many of which are invasive, the Arkansas Game and Fish Commission (AGFC) led the formation of state-wide Task Force in 2007 which developed a state plan (AR ANS MP 2013) that was approved by the Aquatic Nuisance Species Task Force in 2013. The need for state and interjurisdictional ANS plans is recognized in the National Invasive Species Act 1996 (PL 104-332).

With funding from the U.S. Fish and Wildlife Service for implementation, the plan's goal is to:
"prevent the introduction, establishment, and spread of aquatic nuisance species, and to eradicate, where feasible, existing aquatic nuisance species in order to minimize economic and environmental harm in Arkansas."

Within the comprehensive plan are six objectives that address:

1. Coordination
2. Education

3. Rapid Response and Recovery
4. Prevention
5. Management and Control of ANS
6. Potential New ANS and Pathways for Introduction into AR

Importantly for this risk assessment, it also addresses existing priority species, new species of concern and new pathways for introduction into Arkansas.

Pathways being addressed are: 1) unintentional introductions, 2) deliberate, unlawful introductions, and 3) introductions through natural spread. For the purposes of this risk assessment, all three are relevant to the potential risk for importation of golden shiners to Minnesota.

Pathways for Spread in Arkansas
Key pathways for AIS spread were reviewed as part of the AIS state plan including aquaculture, recreational watercraft, collectors, dive operations, escaped captivity, fishing gear, man-made convenience systems, seafood products, fish management, water-hauling vehicles, aquarium-pet-water garden sympathy release, wild-caught bait and bait dumping, egocentric stocking and natural spread (AR ANS MP 2013). Understanding how AIS spread via all pathways is important to protect aquaculture facilities from contamination. As the second-leading state nationally in aquaculture production, protecting the permitted fish farms from AIS impacts is critical to the economic viability of Arkansas.

Regulatory Authority over Aquaculture

AGFC has regulatory authority over fisheries and aquaculture species in Arkansas. All private aquaculture facilities are required to obtain a fish farm permit. AGFC classifies species cultured at three levels: approved, restricted and unlisted.

- Approved species can be freely imported into the state for aquaculture purposes. There are 81 fish, three crustaceans, and two amphibians on the approved list (AR ANS Management Plan 2013, page 253).
- Facilities rearing restricted species must have a Restricted Species Possession Permit in addition to fish farming permit. Facilities with Restricted Species Possession Permits are required to provide an additional level of escape prevention. They must also provide details on location of facility, control measures taken to eliminate possibility of escape, and numbers and species held. Culture ponds are required to have a barrier to prevent juvenile and adult fish from escaping. Pond drainpipes are double screened to prevent passage of any permitted fish in the pond. There are four restricted species: European rudd, diploid black carp, silver carp, and bighead carp (AR ANS Management Plan 2013, page 256).
- If an unlisted species is requested by an applicant, life history of the species and culture plan is reviewed by AGFC biologists to determine risk for escape. If escape is assessed to be low, an Unlisted Species Possession Permit is issued.

Permits for facilities are renewed annually. In summary, the AGFC permitting system appropriately takes into account risks based on species, facilities, and preventative controls.

Approach to Prioritization of AIS in Arkansas

The Arkansas ANS Management Plan identified species already found in the state and identified many others of concern not yet found there as of 2008. The Arkansas ANS Task Force used expert opinion to

prioritize which pathogens, plant/algae, mollusks, crustaceans, insects, fish, birds, and mammals constituted concerns. Species were scored for invasiveness, nuisance, health threat, economic damage, ecological damage and control feasibility. The AR ANS Management Plan then developed three categories for prioritization – identifying the species that they wanted to control, those that they wanted to contain, and those that they wanted to prevent from becoming established in the state. For each of the species in each of the three categories they ranked their priority as (high/medium/low). A summary of the priorities within each of the three categories can be found in APPENDIX H.

Risks Associated with Importation of Golden Shiners from Arkansas

Summary of Risks

Twenty-seven diseases, parasites, non-native fish, and other organisms of concern were identified in the request for proposals. During the course of this project, more organisms of concern were added to assess as potential risks. All organisms of concern are identified in a matrix (APPENDIX A) that assesses the risks posed by each by examining the following risk assessment criteria:

1. Is the organism of concern certified by the AR certification program?
    - Yes or No
2. What is the distribution of the organism in AR?
    - Common, Fairly Common, Uncommon, Stray, Not Detected, Unknown
3. What is the distribution of the organism in MN?
    - Common, Fairly Common, Uncommon, Stray, Not Detected, Unknown
4. What is the likelihood the organism would be transferred with baitfish?
    - High, Medium, Low
5. What is the likelihood the organism will become established in MN if transferred?
    - High, Medium, Low
6. What would the impact be if established?
    - Severe, Moderate, Low, Unknown
7. What is the likelihood the organism could enter waters of the state via another pathway?
    - High, Moderate, Low, Unknown

Definitions

Definitions used to determine distribution in Arkansas and Minnesota

Common – Frequently encountered, widespread, and abundant in the state.

Fairly Common – Either widespread but not abundant in any location or abundant in limited areas of the state.

Uncommon – Not widespread or abundant in any locations in the state.

Stray – Detected in the state, but reproductive status or current presence is unknown.

Not Detected – Surveys have been conducted but the organism has never been found in the state.

Unknown -- Currently unrankable due to lack of information and/or surveys

Definitions for likelihood of transfer with golden shiners

High –The organism has been known to be shipped with golden shiners.
Medium –This rank is used when BMPs or testing is in place to minimize the presence, but the organism has been found on baitfish farms.
Low – The organism is not found in Arkansas, is not known to infect golden shiners, is part of the certification program, or so rare it is unlikely to contaminate baitfish shipments.

Definitions used for likelihood of establishment in Minnesota waters
High – It is highly likely the organism will become established in the state.
Medium – It is unknown whether the organism could become established, but there is a reasonable expectation that it might if released into waters of the state.
Low -- It is highly unlikely that the organism will become established if released into waters of the state.

Definition of impact to state if established in Minnesota waters
Severe – Impacts would be widespread, would significantly disrupt native species assemblages, and would have population level impacts to native or intentionally introduced species.
Moderate – The impacts are either severe but localized or widespread but not expected to have significant population level impacts.
Low – Impacts are expected to be non-existent or inconsequential.
Unknown – There is no information available to make any reasonable prediction of impacts within the state.

Definition of likelihood of organism entering state waters via another pathway
High – There is a very high likelihood that the organism will be introduce to waters of the state via other pathways.
Medium – There are potential pathways that could allow the organism into waters of the state, but they are either not as well defined or not as likely as for the high ranking.
Low – It is unlikely, although still possible, the organism could reach waters of the state via other pathways.
Unknown – There is not enough information to rank the risk of the organism entering state waters via another pathway.

A written justification for each of these seven risk assessment criteria for 33 organism of concern is found below. I searched for available literature and interviewed selected experts to inform my risk ranking for each of the criteria. For some organisms, information was contradictory or unclear and in those cases I used my best judgement to assign a ranking

To identify the greatest risk to the natural resources of Minnesota through the importation of golden shiners from Arkansas, three of the seven criteria (above) were used:

- What is the likelihood the organism would be transferred with baitfish?
    - High or Medium
- What is the likelihood the organism will become established in MN if transferred?
    - High or Medium
- What would the impact be if established?
    - Severe or moderate

If the ranking for the risks for those three criteria were high (or severe) or medium (or moderate), then those organisms of concern were identified as higher priority risks and I describe the risk in more detail and suggest strategies for risk mitigation.
Review of the Matrix (APPENDIX A) suggests that five species fit these criteria. While ten organisms pose a severe impact to Minnesota aquatic resources, many of those were not selected for further discussion because it was deemed that their likelihood of being transferred with baitfish was low.
I identified these five organisms as relatively moderate to high risk:

- Asian Tapeworm (*Schyzocotyle acheilognathi*)
- Golden Shiner Virus
- Ovarian parasite (*Ovipleistophora ovariae*)
- Western Mosquitofish (*Gambusia affinis*)
- Non-native Crayfish (*Procambarus acutus* and *P. clarkii*)

Risk Assessment Matrix Justification

The risks of 17 pathogens, nine fish, four invertebrates, and three plants were assessed in the risk assessment matrix (APPENDIX A). A justification for each risk assessment ranking is provided here.

Viral Hemorrhagic Septicemia (VHSV)

Certified by Arkansas: **Yes**. VHSV is part of the Certification of Commercial Bait and Ornamental Fish Program in AR. VHSV is an OIE reportable aquatic animal pathogen[1].

Distribution in Arkansas: **Not Detected**. VHSV has not been detected in the state (Kelly Winningham, personal communication, 12/06/17). The waters of the state and fish farms may be too warm for establishment of VHSV in AR (Dr. Nicholas Phelps, personal communication, 12/04/17).

Distribution in Minnesota: **Uncommon**. VHSV has only been found in Lake Superior and is assumed to be in fish in tributaries up to the first fish barrier. VHSV has not been found anywhere else in the state. This is a certifiable disease in MN[2], but inspections are only required for VHSV-susceptible species – golden shiners are not listed as susceptible.

Likelihood of transfer: **Low**. It is unlikely that VHSV would ever be carried into MN via importation of golden shiners from AR. VHSV has never been found in AR, waters of the state may be too warm for VHSV to establish, and the baitfish certification program tests for VHSV.

Likelihood of establishment: **High**. If VHSV were to reach uninfested waters of MN it is very likely that it would become established.

Impact if established: **Severe**. With possibly one exception, VHSV has not caused population level impacts in the Great Lakes and other inland lakes (like Lake Winnebago) where it has caused fish kills. Fish populations generally build immunity and rebound rather quickly (Myron Kebus, (personal communication, 12/19/2017) so the impact if established in MN waters could be listed as low or moderate. However, muskies in the St. Lawrence River have experienced significant mortality and have not rebounded (Casselman 2011). For this reason, potential impact is considered severe if established in MN waters.

Likelihood of other pathways: **Moderate.** There is a moderate likelihood that VHSV could be moved into uninfested MN waters through other pathways. VHSV has been found in inland lakes away from the Great Lakes in WI, MI, and OH. VHSV could be moved by the illegal movement of baitfish or fish for stocking from VHSV-endemic areas. It is also possible the virus could be transferred by fish or fish entrails from infected areas or fish movement through connected waters.

Infectious Hematopoietic Necrosis (IHN)

Certified by Arkansas: **Yes.** IHN is part of the Certification of Commercial Bait and Ornamental Fish Program in AR. IHN is an OIE reportable aquatic animal pathogen[1].

Distribution in Arkansas: **Not Detected.** IHN has not been detected in the state (Kelly Winningham, personal communication, 12/06/17 and AR ANS MP 2013).

Distribution in Minnesota: **Not Detected.** IHN is not found in MN. This is a certifiable disease in MN[2].

Likelihood of transfer: **Low.** It is unlikely that IHN would ever be carried into MN via importation of golden shiners from AR. IHN is not found in AR, it is primarily a salmonid disease (Dixon et al. 2016), golden shiners are not susceptible to IHN (Dr. Anita Kelly, personal communication, 12/8/17), and the baitfish certification program tests for IHN.

Likelihood of establishment: **High.** If IHN were to reach the waters of MN with salmonids it is likely that it would become established.

Impact if established: **Moderate.** IHN is primarily a concern for fry and juvenile salmonids in hatcheries or on fish farms where it can have severe impacts. Its impact in the wild is not as great even though occasional epizootics have occurred in wild salmon (Iowa State University Center for Food Security and Public Health 2007a). Overall, I considered the risk to be moderate.

Likelihood of other pathways: **Low.** There is a low likelihood that IHN could be moved into MN waters through other pathways. IHN is moved with salmonids and salmonid eggs. Existing regulations and testing protocols greatly reduce the risk (Minnesota Statutes, sections 17.4986) if rules are followed and testing is accurate.

Infectious Pancreatic Necrosis (IPN)

Certified by Arkansas: **Yes.** IPN is part of the Certification of Commercial Bait and Ornamental Fish Program in AR.

Distribution in Arkansas: **Uncommon**. IPN has only been detected in one state-run culture facility and 4 trout waters in the state (Spring River, Little Missouri River, Bull Shoals Tailwater (below the dam of the lake, not in the lake), and Little Red River). Stocking source changes have led to the pathogen no longer being detected in the Little Red River drainage (Kelly Winningham, personal communication, 01/04/18).

Distribution in Minnesota: **Stray.** IPN is not found in MN except for one instance when trout stocked into a pond in northern MN tested positive for IPN

(www.twincities.com/2009/02/07/slip-up-by-the-minnesota-dnr-allowed-fish-virus-into-state/). The population was depopulated. This is a certifiable disease in MN[2].

Likelihood of transfer: **Low.** It is unlikely that IPN would ever be carried into MN via importation of golden shiners from AR. IPN is not common outside of north AR trout waters (AR ANS MP 2013), it is primarily a salmonid disease, golden shiners are not susceptible to IPN and the baitfish certification program tests for IPN.

Likelihood of establishment: **High.** If IPN were to reach the waters of MN with salmonids, it is likely that it would become established.

Impact if established: **Low.** IPN is primarily a concern for salmonids less than 6 months old in hatcheries or on fish farms. Despite the wide spread occurrence of the IPN virus in Scottish and Norwegian salmon farms, no significant effect on wild fish has been found (Ruane 2007). Therefore, I considered the potential impact if introduced into MN as low.

Likelihood of other pathways: **Low.** There is a low likelihood that IPN could be moved into MN waters through other pathways. IPN is moved with salmonids and salmonid eggs. Existing regulations and testing protocols greatly reduce the risk (Minnesota Statutes, sections 17.4986) if rules are followed and testing is accurate.

Fathead Minnow Nidovirus (FHMNV)

Certified by Arkansas: **Yes.** FHMNV is part of the Certification of Commercial Bait and Ornamental Fish Program in AR, if requested.

Distribution in Arkansas: **Not Detected**. FHMNV has not been detected in farmed fish in AR since the original outbreak was detected. FHMNV was eradicated from farmed and wild fish in AR (Batts et al. 2012).

Distribution in Minnesota: **Unknown**. FHMNV has been detected in one fathead minnow farm in Minnesota (Dr. Nicholas Phelps, personal communication, 1/02/18). However, McCann (2012) found that over 12% of fathead minnow lots from bait shops from AR, SD, and MN tested positive for FHMNV. State specific information was not presented, but this suggests fathead minnows in MN could be infected. More surveillance for this pathogen is needed in MN. This is not a certifiable disease in MN[2].

Likelihood of transfer: **Low.** It is unlikely that FHMNV would ever be carried into MN via importation of golden shiners from AR. FHMNV has not been found in farmed fish in AR (since the original case) and the AR baitfish certification program will test for it if requested. Golden shiners can carry the virus (Baird 2015).

Likelihood of establishment: **High.** If FHMNV were to reach the waters of MN it is likely that it would become established.

Impact if established: **Moderate.** FHMNV is an emerging disease and causes mortality in fathead minnows and muskellunge in hatcheries (Baird 2015) which is why the potential impact is considered moderate. If significant mortality of muskellunge occurs in the wild from this virus, the risk should be elevated.

Likelihood of other pathways: **Moderate.** There is a low likelihood that FHMNV could be moved into MN waters through other pathways, however, it could be moved into the state by anglers bringing illegal bait into the state, anglers using contaminated bait in border waters, or by moving through connected waterways.

Spring Viremia of Carp (SVC)

Certified by Arkansas: **Yes**. SVC is part of the Certification of Commercial Bait and Ornamental Fish Program in AR. SVC is an OIE reportable aquatic animal pathogen[1].

Distribution in Arkansas: **Not Detected**. SVC has not been detected in the state.

Distribution in Minnesota: **Uncommon**. SVC has only been found in Minnehaha Creek and Pool 8 of the Mississippi River (Phelps et al. 2012 and USFWS National Wild Fish Health Survey). SVC has not been found anywhere else in the state. This is not a certifiable disease in MN[2].

Likelihood of transfer: **Low**. It is unlikely that SVC would be carried into MN via importation of golden shiners from AR. SVC has never been found in AR and the baitfish certification program tests for SVC. SVC can, however, be carried by golden shiners as well as a number of other species (Iowa State University Center for Food Security and Public Health 2007b).

Likelihood of establishment: **High**. If SVC were to reach uninfested waters of MN it is likely that it would become established.

Impact if established: **Low**. SVC primarily affects common carp but can also affect bighead, silver, and grass carp and goldfish (Spring viremia of carp fact sheet 2007) so, therefore, the risk is considered low.

Likelihood of other pathways: **Moderate**. There is a moderate likelihood that SVC could be moved into uninfested MN waters through other pathways. SVC could be moved by anglers with baitfish from infected areas, transfer of fish or fish entrails from infected areas, by illegal movement of fish for stocking, or via connected waterways.

Heterosporis sutherlandae

Certified by Arkansas: **Yes.** *Heterosporis* is part of the Certification of Commercial Bait and Ornamental Fish Program in AR, if requested.

Distribution in Arkansas: **Not Detected**. *Heterosporis* has not been detected in fish from AR.

Distribution in Minnesota: **Uncommon**. First found in MN in 2000, *Heterosporis* is now found in 26 lakes, including waters with active harvest of wild baitfish (Dr. Nicholas Phelps, personal communication, 1/2/18). This is not a certifiable disease in MN[2].

Likelihood of transfer: **Low**. It is unlikely that *Heterosporis* would be carried into MN via importation of golden shiners from AR. *Heterosporis* has not been found in AR and the baitfish certification program looks for it.

Likelihood of establishment: **High**. If *Heterosporis* were to reach uninfested waters of MN it is likely that it would become established.

Impact if established: **Low**. Impact if established in uninfested waters is listed as low because there is no information that suggests that *Heterosporis i*s having a negative impact at the population level for any of the 15 species it is known to infect.

Likelihood of other pathways: **High**. Likelihood of Heterosporis moving to uninfested waters via other pathways is listed as high because it is found in 26 MN lakes and it could be moved with bait, water, fish or fish entrails moved from one lake to another or via connected waterways.

Golden Shiner Virus (GSV)

Certified by Arkansas: **Yes.** GSV is part of the Certification of Commercial Bait and Ornamental Fish Program in AR, if requested.

Distribution in Arkansas: **Common**. GSV is common in AR.

Distribution in Minnesota: **Unknown**. GSV has not been found in the wild in MN but has been detected in golden shiners collected in bait shops in MN (Dr. Nicholas Phelps, personal communication, 12/04/17). This is not a certifiable disease in MN[2].

Likelihood of transfer: **Medium**. GSV is listed as a medium risk for being transferred with golden shiners. It is common in AR, but the Baitfish Certification program will test for GSV. While not all farms will be free of the virus, some will be (Dr. Anita Kelly, personal communication, 12/08/17).

Likelihood of establishment: **High**. If GSV were to reach the waters of MN it is likely that it would become established. McCann (2012) found that 41% of golden shiner lots, 32% of fathead minnow lots, and 5% of white sucker lots tested positive for GSV. But Kelly Winningham (personal communication, 12/06/17) said the even though they feed fathead minnows with GSV to sport fish that are stocked into public waters, they don't find golden shiner virus in the wild in AR. I decided to rank the likelihood as high based on the infection rate McCann found in baitfish she tested.

Impact if established: **Moderate**. Impacts are considered by some to be low, because the virus exhibits little or no pathogenicity (Dr. Nicholas Phelps, personal communication, 12/04/17), but others have reported mortality in muskies in hatcheries from WI and MI from this virus (Boonthai et al. in review). While the impact to muskellunge in the wild is not documented, this risk was elevated to moderate because of the potential to impact wild muskellunge populations.

Likelihood of other pathways: **Moderate.** There is a moderate likelihood that GSV could be moved into MN waters through other pathways. It could be moved into the state by anglers bringing illegal bait into the state, anglers using infected bait from another state in border waters, or through connected waterways. For example, anglers could be legally using infected bait on border waters with WI, IA, SD, ND or ONT. Golden shiner virus has also been found in fathead minnows, white suckers, emerald shiners, silver carp, and smallmouth buffalo (McCann 2012).

Asian Tapeworm (*Schyzocotyle acheilognathi*)

Certified by Arkansas: **Yes.** Monitoring for Asian tapeworm is part of the Certification of Commercial Bait and Ornamental Fish Program in AR, if requested.

Distribution in Arkansas: **Fairly Common**. Asian tapeworm is fairly common in AR (Dr. Anita Kelly, personal communication, 12/08/17).

Distribution in Minnesota: **Unknown**. Asian tapeworm has not been detected in MN, but there has been little surveillance for this parasite. This is not a certifiable disease in MN[2].

Likelihood of transfer: **Medium**. Asian tapeworm is a medium risk for being transferred with golden shiners because it is found on some golden shiner farms in AR. However, the baitfish certification program will test for Asian tapeworm if requested. While not all farms will be free of Asian tapeworm, some have been certified free of Asian tapeworm (APPENDIX C) (Dr. Anita Kelly, personal communication, 12/08/17).

Likelihood of establishment: **High**. If Asian tapeworm were to reach the waters of MN it is likely that it would become established.

Impact if established: **Moderate**. There is little known about impacts in the wild, but it has been suggested that Asian tapeworms could have population level impacts to important forage fish (Muzall et al. 2016). Even though golden shiners (some likely infected with Asian tapeworms) have been imported into WI for over 20 years they have not seen problems associated with Asian tapeworm in the wild (Dr. Myron Kebus, personal communication, 12/19/2017). But, because of the potential impact described by Muzall et al. (2016) I ranked the impact as moderate.

Likelihood of other pathways: **Moderate**. There is a moderate likelihood that Asian tapeworm could be moved into MN waters through other pathways. It could be moved into the state by anglers bringing illegal bait into the state, anglers using infected bait from another state in border waters, or via connected waterways. For example, anglers could be legally using infected bait on border waters with WI, IA, SD, ND or ONT. Muzzall et al (2016) documented the range expansion of Asian tapeworm into Lakes St. Claire and Huron. Because Asian tapeworm infects over 200 fish species and infects a variety of cyclopoid copepods, they believe Asian tapeworms will spread throughout the Great Lakes Basin and expand into inland waters. Therefore, Asian tapeworm may eventually be found in MN waters of Lake Superior and its tributaries. Asian tapeworm also infects invasive carps which, if infected, could bring them into the state via connected waters.

Koi Herpes Virus (KHV)

Certified by Arkansas: **Yes**. KHV is part of the Certification of Commercial Bait and Ornamental Fish Program in AR for goldfish and koi. They will test golden shiners if requested. KHV is an OIE reportable aquatic animal pathogen[1].

Distribution in Arkansas: **Uncommon***.* KHV is uncommon in AR. The virus has only been found in private pools. It has not been found in the wild or on fish farms (AR ANS MP 2013).

Distribution in Minnesota: **Uncommon** KHV was found in nine lakes in Southern MN and caused significant carp kills June-August 2017 (news.dnr.state.mn.us/2017/07/27/virus-that-affects-carp-responsible-for-lake-elysian-fish-kill/). It was also found in a private facility in 2004. The facility was depopulated and disinfected (Joe Marcino 2005 report to the Great Lakes Fish

Health Committee; www.glfc.org/pubs/fhealth/2005agencyreports.pdf). The virus was also found in a backyard pond in 2009 which was subsequently depopulated and disinfected (Dr. Nicholas Phelps, personal communication, 1/2/18). This is not a certifiable disease in MN[2].

Likelihood of transfer: **Low**. KHV is considered a low risk for being transferred with golden shiners. It is found in AR, but the Baitfish Certification program will test for KHV in golden shiners if requested. They normally only test goldfish and koi for KHV. KHV is found primarily in carp and goldfish and has never been found in golden shiners (Dr. Nicholas Phelps, personal communication, 12/04/17).

Likelihood of establishment: **High**. If KHV were to reach the waters of MN where carp are present it is likely that it would become established.

Impact if established: **Low**. The impact is listed as low, because the virus exhibits no pathogenicity to species other than carp and goldfish (Dr. Nicholas Phelps, personal communication, 12/04/17). There are, however, commercial fisheries for carp in MN that could be impacted.

Likelihood of other pathways: **Moderate**. There is a moderate likelihood that KHV could be moved into MN waters through other pathways. It could be brought into the state by infected ornamental fish like koi or goldfish, which are often released by aquarists or could escape outdoor ponds during flooding.

Whirling Disease (*Myxobolus cerebralis*)

Certified by Arkansas: **No**. Whirling disease is not certified by the AR program. Whirling disease is an OIE reportable aquatic animal pathogen[1].

Distribution in Arkansas: **Not Detecte**d. Whirling disease is not found in AR.

Distribution in Minnesota: **Not Detected**. Whirling disease is not found in MN. This is a certifiable disease in MN[2].

Likelihood of transfer: **Low**. Whirling disease is considered a low risk for being transferred with golden shiners because baitfish are not susceptible. It is primarily a disease of salmonids so this parasite would not be found on any baitfish farms in AR. There are no private trout farms in AR (Kelly Winningham, personal communication, 12/15/17).

Likelihood of establishment: **Medium**. If whirling disease were to reach the waters of MN where salmonids are present it is likely that it would become established.

Impact if established: **Severe**. Impact is listed as severe because the whirling disease can have significant impacts on cultured and wild salmonids if it becomes established as demonstrated in several western states (Nehring and Walker 1996; Steinbach Elwell et al. 2009).

Likelihood of other pathways: **Low**. There is a low likelihood that whirling disease could be moved into MN waters through other pathways. Whirling disease is a reportable aquatic animal pathogen and all salmonids moving into MN must come from facilitates free of the disease for three years or eggs must be properly treated if they come from a facility with whirling disease (Minnesota Statutes, sections 17.4986).

Edwardsiella tarda

Certified by Arkansas: **Yes.** *E. tarda* is part of the Certification of Commercial Bait and Ornamental Fish Program in AR, if requested.

Distribution in Arkansas: **Uncommon** It is uncommon in AR, but inconsistencies in naming protocols have led to uncertainty concerning its actual distribution; there is some indication that what has been called *E. tarda* is actually *E. piscicida* (Dr. Anita Kelly, personal communication, 12/08/17).

Distribution in Minnesota: **Uncommon**. *Edwardsiella tarda* has been found in borders waters in MN. It was reported in the Mississippi River and Lake Traverse on the border with South Dakota (USFWS National Wild Fish Health Survey). This is not a certifiable disease in MN[2].

Likelihood of transfer: **Low***.* It is unlikely that either *E. tarda* or *E. piscicida* would be transferred to MN through importation of golden shiners from AR. These bacteria are primarily found in catfish and largemouth bass and not in golden shiners. In addition, holding vats used for baitfish are never used for holding sport fish (Mark Stoll, personal communication, 12/11/17).

Likelihood of establishment: **High***.* If *E. tarda* or *E. piscicid*a were moved into Minnesota, there is a high likelihood that they could become established.

Impact if established: **Low**. The impact of these bacteria if established is listed as low because there is little evidence that there are impacts on wild fish. *E. tarda* can also infect immune compromised humans.

Likelihood of other pathways: **Moderate**. There is a moderate likelihood that *E. tarda* and/or *E. piscicida* could enter other waters of the state because they have been found in boundary waters and could be moved by anglers or others.

Largemouth Bass Virus (LMBV)

Certified by Arkansas: **Yes.** LMBV is part of the Certification of Commercial Bait and Ornamental Fish Program in AR, if requested.

Distribution in Arkansas: **Common**. LMBV is common in AR, however, there have only been two significant fish kills of largemouth bass in the wild. There have been no significant fish kills since 2001 (Kelly Winningham, personal communication, 12/06/17).

Distribution in Minnesota: **Uncommon**. LMBV has been found in five lakes in Minnesota (Dr. Nicholas Phelps, personal communication, 12/04/17) and the Mississippi River (USFWS National Wild Fish Health Survey). This is not a certifiable disease in MN[2].

Likelihood of transfer: **Low**. The likelihood of being moved into MN via imported AR golden shiners is listed as low because golden shiners are not susceptible to the disease and if largemouth bass are grown on farms that are part of the baitfish certification program, they are kept separated. Holding vats used for baitfish are never used for holding sport fish (Mark Stoll, personal communication, 12/11/17).

Likelihood of establishment: **High**. Since LMBV is already found in five MN lakes and the Mississippi River, the likelihood that the disease would become established in other lakes if introduced is considered high.

Impact if established: **Low**. LMBV is widely found throughout the eastern and central U.S. It has likely been responsible for largemouth bass fish kills, but there is no evidence that it has resulted in any long-term problems for largemouth bass populations. Therefore, the impact is considered low.

Likelihood of other pathways: **Moderate***.* Since LMBV is already found in five MN lakes, the likelihood of the virus being moved to uninfested waters is considered moderate. Anglers could illegally move fish or fish entrails from one lake to another or they could move water containing the virus.

Channel Catfish Virus

Certified by Arkansas: **No**. Channel catfish virus is not part of the Certification of Commercial Bait and Ornamental Fish Program in AR.

Distribution in Arkansas: **Uncommon**. Channel catfish virus is uncommon in AR and primarily seen in catfish raised for food. It does not appear in the wild (Kelly Winningham, personal communication, 12/06/17).

Distribution in Minnesota: **Not Detected**. Channel catfish virus has not been detected in MN. This is a certifiable disease in MN[2].

Likelihood of transfer: **Low**. It is unlikely this virus would be moved with golden shiners. Golden shiners are not susceptible and channel catfish do not come into contact with ponds or vats used for baitfish.

Likelihood of establishment: **Low***.* Likelihood of this becoming established in MN is listed as low because it is primarily a disease found in catfish farms.

Impact if established: **Low**. This virus does not appear to have any impact on wild populations. Outbreaks are primarily in small/young catfish on farms (Kelly Winningham, personal communication, 12/06/17).

Likelihood of other pathways: **Low**. It is unlikely that this virus would be moved into Minnesota. Channel catfish are infrequently imported into MN and existing regulations and testing protocols greatly reduce the risk (Minnesota Statutes, sections 17.4986) if rules are followed and testing is accurate.

Enteric Septicemia of Catfish (ESC)

Certified by Arkansas: **No**. ESC is not certified by the Certification of Commercial Bait and Ornamental Fish Program in AR.

Distribution in Arkansas: **Common**. ESC is common in AR. ESC is found wherever catfish are farm raised.

Distribution in Minnesota: **Not Detected**. ESC has not been detected in MN. This is a certifiable disease in MN[2].

Likelihood of transfer: **Low**. It is unlikely that this disease would be moved with golden shiners from AR. It primarily infects cultured catfish. Golden shiners are not susceptible and not known to carry the disease. Golden shiners are not raised where catfish can escape into golden shiner ponds and if catfish are raised on a baitfish farm, the vats used to hold harvested baitfish and other equipment are not used for catfish (or any other sport fish). Only two fish kills in the wild have been documented (Hawke 2015).

Likelihood of establishment: **Low**. This disease is primarily a disease on catfish farms, so the likelihood of it becoming established in MN is considered low.

Impact if established: **Low**. Because there is not a significant catfish farming industry, the impact to MN would be minimal and is therefore, considered low.

Likelihood of other pathways: **Low**. This is primarily a disease associated with farm-raised catfish and existing regulations and testing protocols greatly reduce the risk (Minnesota Statutes, sections 17.4986) if rules are followed and testing is accurate. Therefore, the likelihood of it being brought into the state through other pathways is considered low.

Ovarian Parasite (*Ovipleistophora ovariae*)

Certified by Arkansas: **No**. *Ovipleistophora ovariae* is not certified by the Certification of Commercial Bait and Ornamental Fish Program in AR.

Distribution in Arkansas: **Common**. *O. ovariae* is common in golden shiners raised for bait in AR.

Distribution in Minnesota: **Stray**. Distribution in the wild is unknown, but golden shiner samples taken from bait stores in MN had an infection rate of 56% (Dr. Nicholas Phelps, personal communication, 12/04/17), which could suggest that it is fairly common in the state if that sample is representative of incidence in golden shiners sold in MN and anglers have moved the parasite around the state. Further research is needed to determine if this high infection rate is representative of wild and Minnesota-grown golden shiners. Because infection rate in wild fish is unknown, the distribution is considered stray. This is not a certifiable disease in MN[2].

Likelihood of transfer: **High**. Because infection rate of *O. ovariae* is high in farmed golden shiners, the likelihood that it would be transferred to MN with golden shiners imported from AR is considered high.

Likelihood of establishment: **High**. *O. ovariae* is commonly found in farm-raised golden shiners throughout the U.S., however, it is rarely reported in feral populations (Summerfelt and Goodwin 2010). The likelihood of establishment in Minnesota is considered high because golden shiners are widespread throughout MN and appear to be susceptible, but it could be that the disease is less likely to establish in feral populations than in farmed populations. Research to examine the prevalence of *O. ovariae* in wild populations is needed.

Impact if established: **Severe**. Impact of *O. ovariae* on golden shiner reproduction is severe. Over time, the parasite reduces fecundity or causes sterilization of female golden shiners. Because

golden shiners are naturally fecund fish, AR baitfish farmers have overcome the problem by using only yearling brood fish because incidence of infection increases with age. Impacts in wild populations have not been detected and are unknown. Risk level could be lowered if no impacts to wild populations occur.

Likelihood of other pathways: **High**. Because 56% of golden shiners sampled in bait shops in MN were infected with *O. ovariae* (Dr. Nicholas Phelps, personal communication, 12/04/17), it is likely that if it is able to become established in wild populations of golden shiners it will spread throughout the state, if it hasn't already. Likelihood that it will spread regardless of importing golden shiners from AR is listed as high because it is already in the MN bait supply.

Furunculosis (*Aeromonas salmonicida*)

Certified by Arkansas: **Yes.** Furunculosis is part of the Certification of Commercial Bait and Ornamental Fish Program in AR.

Distribution in Arkansas: **Uncommon.** Furunculosis has been found in trout in the AR state hatchery system but has not been found in warm water species (Kelly Winningham, personal communication, 12/15/17). Furunculosis has never been found in any farmed fish in AR (Dr. Anita Kelly, personal communication, 12/15/17).

Distribution in Minnesota: **Common.** Furunculosis was found in 3 out of 52 baitfish collected at bait shops around the state (Dr. Nicholas Phelps, personal communication, 12/04/17). Furunculosis has been found in Minnesota state hatcheries which were then decontaminated. Crystal Springs State Hatchery was depopulated in 2015 due to a furunculosis outbreak. The hatchery was likely contaminated by flooding. This suggests that furunculosis may be endemic in wild fish (Dr. Nicholas Phelps, personal communication, 12/15/17). This is a certifiable disease in MN[2].

Likelihood of transfer: **Low**. It is unlikely that furunculosis would be carried into MN via importation of golden shiners from AR. Furunculosis has never been found in warm water fish or on fish farms in AR (Dr. Anita Kelly and Kelly Winningham, personal communication, 12/15/17) and the baitfish certification program tests for furunculosis. Furunculosis can, however, be carried by golden shiners as well as a number of other species.

Likelihood of establishment: **High**. If furunculosis were to reach uninfested waters of MN there is a high likelihood that it would become established in salmonid waters as well as some others, in part because furunculosis has a broad host range. (Dr. Nicholas Phelps, personal communication, 12/15/17).

Impact if established: **Moderate.** The impact is expected to be low for most species, but it could have moderate to high impacts on salmonid populations. Overall impact is considered moderate even though furunculosis may already be endemic in wild fish so the impact of new introductions could be considered low.

Likelihood of other pathways: **Low.** The most likely pathway is trout stock enhancement and current regulations protect against this (Minnesota Statutes, sections 17.4986) if rules are followed and testing is accurate.

Enteric Redmouth Disease (*Yersinia ruckeri)*

Certified by Arkansas: **Yes.** Enteric redmouth disease is part of the Certification of Commercial Bait and Ornamental Fish Program in AR.

Distribution in Arkansas: **Uncommon.** Enteric redmouth disease has been found in trout in the Arkansas state hatchery system but has not been found in warm water species (Kelly Winningham, personal communication, 12/15/17). Enteric redmouth disease has never been found in any farmed fish in AR (Dr. Anita Kelly, personal communication, 12/15/17).

Distribution in Minnesota: **Uncommon.** Enteric redmouth disease was found in golden shiners at 2 out of 52 bait shops as part of 2015 bait shop survey and it is unknown if there have been other outbreaks (Dr. Nicholas Phelps, personal communication, 12/15/17). The USFWS National Wild Fish Health Survey indicates that enteric redmouth disease has been found in the St. Louis River Estuary, Lake Superior, the Mississippi River, and Lake Traverse on the South Dakota border. Crystal Springs hatchery tested positive for enteric redmouth disease in the late 1990's but it did not result in a disease outbreak (Ling Shen, personal communication, 1/19/18). This is a certifiable disease in MN[2].

Likelihood of transfer: **Low**. It is unlikely that enteric redmouth disease would be carried into MN via importation of golden shiners from AR. Enteric redmouth disease has never been found in warm water fish or on fish farms in AR (Dr. Anita Kelly and Kelly Winningham, personal communication, 12/15/17) and the baitfish certification program tests for enteric redmouth disease. Enteric redmouth disease can, however, be carried by golden shiners as well as a number of other species.

Likelihood of establishment: **High**. If enteric redmouth disease were to reach waters not yet infested there is a high likelihood that it would become established in both salmonid waters as well as in other waters, in part because it can infect many different species of fish including fathead minnows, goldfish, and emerald shiners. It has even been found in turtles, birds and muskrats (Kumer et al. 2015).

Impact if established: **Low.** The impact is expected to be low for most species, but it could have moderate to high impacts on salmonid populations in hatcheries and aquaculture facilities (Kumar et al. 2015). It is difficult to find evidence of enteric redmouth disease impacting wild populations so the overall impact is considered low.

Likelihood of other pathways: **Low.** The most likely pathway is trout stock enhancement and current regulations protect against this (Minnesota Statutes, sections 17.4986) if rules are followed and testing is accurate.

Bighead Carp (*Hypophthalmichthys nobilis*)

Certified by Arkansas: **Yes**. Bighead carp are part of the Certification of Commercial Bait and Ornamental Fish Program in AR. Bighead carp are listed as an Injurious Species under Lacey Act[3].

Distribution in Arkansas: **Fairly Common**. Bighead carp are established in the Mississippi River basin, the White River and other tributaries in AR (USGS NAS, December 2017). Bighead carp are a restricted aquaculture species in AR[4] (AR ANS MP 2013).

Distribution in Minnesota: **Uncommon**. Bighead carp have been found in the Mississippi River, however, their reproductive status in that area is reported as unknown (USGS NAS, December 2017) even though they are reproducing and considered established further downstream, near Keokuk, IA. Bighead carp are a prohibited species in MN[5].

Likelihood of transfer: **Low***.* Bighead carp are a Restricted Species in AR (AR ANS MP 2013). They are not raised on any farms and are certified by the AR certification program, so it is unlikely that they would be moved into MN via importation of golden shiners from AR.

Likelihood of establishment: **Medium**. If bighead carp were imported into areas of the state with large rivers suitable for spawning, it is highly likely they would become established. Estimates of establishment probabilities have been made for the Minnesota River (70%), the lower St. Croix River (45%), the Nemadji River (38%), and the Sand Hill River (22%) (Kokotovich et al. 2017). Bighead carp are not likely to become established widely throughout MN because of habitat requirements. Therefore, likelihood of establishment is considered medium rather than high.

Impact if established: **Moderate**. The impact of bighead carp establishment in MN is considered moderate, in part because bighead carp are likely to be restricted in their range in MN. Kokotovich et al. (2017) has conducted an in depth risk assessment. In waters where they do become established impacts could be severe.

Likelihood of other pathways: **Moderate**. The likelihood of bighead carp entering the waters of the state via pathways other than golden shiner importation is considered moderate. They can easily continue to move into state waters through connected waters. Their movement into other waters of the state is unlikely because of regulations in place and the lack of suitable spawning habitat throughout much of the state. However, they could be introduced by illegal movement of fish or contaminated wild harvested bait.

Black Carp (*Mylopharyngodon piceus*)

Certified by Arkansas: **No**. Black carp are not certified by the Certification of Commercial Bait and Ornamental Fish Program in AR. Black carp are listed as an Injurious Species under Lacey Act[3].

Distribution in Arkansas: **Uncommon**. Black carp have been found in the wild in AR waters and are raised on some farms under special permit and used on other farms for snail control. Snails serve as an intermediate host for unwanted fish parasites, such as yellow grub (Kelly Winningham, personal communication, 12/06/17). Black carp are not raised or used on baitfish farms (Dr. Anita Kelly. Personal communication, 12/08/17). Diploid black carp are a restricted aquaculture species in AR[4] (AR ANS MP 2013). Young of the year black carp have been caught multiple times near Cape Girardeau, MO which suggests they are reproducing in the Mississippi River (Davis 2016).

Distribution in Minnesota: **Not Detected**. Black carp have not been detected in MN waters. Black carp are however, found in the Mississippi river basin. It is likely that they are established or will likely will become established in the lower Mississippi River basin (USGS NAS, December 2017). Black carp are a prohibited species in MN[5].

Likelihood of transfer: **Low**. It is unlikely that black carp would be transferred to MN with imported golden shiners from certified ponds. Even though not specifically certified black carp free by the program, baitfish are raised in monoculture and no black carp are used on baitfish farms.

Likelihood of establishment: **Medium**. Even though black carp continue to be caught occasionally by commercial fishermen, eggs, larvae and spawning are not regularly observed, except as described by Davis (2016). So while it is likely that the large rivers of MN would be suitable for black carp reproduction, it is not clear that they would establish reproducing populations if introduced to waters of the state. Because of uncertainty, their likelihood of establishment is considered medium.

Impact if established: **Moderate**. Because black carp have not become abundant anyplace in the U.S. it is not easy to predict their impact if they become abundant in MN waters. However, because they consume mollusks there is concern that they could place threatened and endangered unionids at even greater risk (Nico et al. 2005). They may also compete with other fish that rely on mollusks for food (Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States, 2007).

Likelihood of other pathways: **Moderate**. The most likely pathway for black carp to enter MN waters is through connected waters. Because no black carp have yet been found in MN even though black carp have been caught in the Mississippi River since the 1990s, the likelihood of this pathway is listed as moderate. If black carp move up the Mississippi River, the likelihood that they would move into other inland waters is considered low because of regulations that are in place to prevent wild bait harvest and the lack of suitable spawning habitat throughout much of the state.

Grass Carp (*Ctenopharyngodon idella*)

Certified by Arkansas: **No.** Grass carp are not certified by the Certification of Commercial Bait and Ornamental Fish Program in AR.

Distribution in Arkansas: **Common**. Grass carp are common in AR and are raised or used for vegetation control on some fish farms and reservoirs.

Distribution in Minnesota: **Uncommon**. Adult grass carp are found in MN waters of the Mississippi River and have been reported in a few other locations like the St. Croix River and Okamanpeedan Lake on the Minnesota-Iowa border. Although several diploid grass carp have been found in MN waters for over 20 years, there is no evidence of a reproducing population. Grass carp are a prohibited species in MN[5].

Likelihood of transfer: **Low**. Even though diploid grass carp are allowed in AR and triploid grass carp are raised on at least one farm, baitfish farmers do not use them for vegetation control in baitfish ponds. The AR farmer raising triploid grass carp is not part of the baitfish certification program (Mark Stoll, personal communication, 12/11/17). Grass carp may be used for vegetation control in ponds where sport fish are grown, but if baitfish are raised on the farm, baitfish holding vats and other equipment are kept separate and not used for sport fish. If only baitfish are raised on the farm, no grass carp are ever on the farm. The vast majority of baitfish

farmers do not raise sportfish so there is very low risk of grass carp being transferred with golden shiners (Dr. Eric Park, personal communication, 1/15/18).

Likelihood of establishment: **Medium**. Grass carp are currently not established in MN waters of the Mississippi River. If grass carp were imported into or moved through connecting channels into other areas of the state with large rivers suitable for spawning, it is likely they would become established. Areas like the Minnesota, St. Croix, and Nemadji Rivers have been identified as potential areas for successful spawning (Kokotovich et al. 2017). Grass carp are not likely to become established widely throughout MN because of habitat requirements. Therefore, the likelihood of establishment is considered medium.

Impact if Established: **Moderate***.* High densities of grass carp have the potential to alter habitats and adversely affect native communities through consumption of aquatic vegetation. They can decrease habitat for aquatic organisms, disrupt food webs, and increase nutrient enrichment and eutrophication of lakes. Impact of grass carp establishment in MN is considered moderate, in part because grass carp are likely to be restricted in their range in MN and on a state-wide level they would not have a high impact. However, their impact could be severe where they become established.

Likelihood of other pathways: **High**. Likelihood of introduction from other pathways is listed as high because of the use of grass carp in vegetation control. IA and 9 other states allows the use of diploid grass carp (Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States, 2007) which could illegally be brought into MN or move in through connected waters.

Silver Carp (*Hypophthalmichthys molitrix*)

Certified by Arkansas: **Yes**. Silver carp are part of the Certification of Commercial Bait and Ornamental Fish Program in AR. Silver carp are listed as an Injurious Species under Lacey Act[3].

Distribution in Arkansas: **Fairly Common**. Silver carp are established in the Mississippi, Ohio, and Missouri River basins and are found in the Arkansas and White Rivers in AR, along with some other locations (USGS NAS, December 2017). Silver carp have not been raised in AR for several decades (AR ANS MP 2013). Silver carp are a restricted aquaculture species in AR[4] (AR ANS MP 2013).

Distribution in Minnesota: **Uncommon**. Only a few adult silver carp have been found in MN waters of the Mississippi and St. Croix Rivers and Okamanpeedan Lake on the Minnesota-Iowa border. The closet reproducing population is in the Mississippi River near Keokuk, IA (as of 1/2018). Silver carp are a prohibited species in MN[5].

Likelihood of transfer: **Low***.* Silver carp are not cultured in AR and they are part of the Certification of Commercial Bait and Ornamental Fish Program. The likelihood of silver carp being transferred with imported golden shiners from AR is considered low.

Likelihood of establishment: **Medium***.* Silver carp are currently found in MN waters of the Mississippi and St. Croix Rivers. If silver carp were imported into or moved through connecting channels into other areas of the state with large rivers suitable for spawning, it is likely they

would become established. Estimates of establishment probabilities have been made for the Minnesota River (70%), the lower St. Croix River (45%), the Nemadji River (38%), and the Sand Hill River (22%) (Kokotovich et al. 2017). Silver carp are not likely to become established widely throughout MN because of habitat requirements (Kokotovich et al. 2017). Therefore, the likelihood of establishment is considered medium rather than high.

Impact if Established: **Moderate**. Impact if established in MN is listed as moderate, because silver carp are not likely to become widely established in MN waters. Where they become established in large river systems, however, their impact will likely be severe. They can become incredibly abundant. They feed on plankton and can compete with other native plankton feeders, larval fish and mussels. Silver carp are also known for jumping out of the water when startled which has caused personal injury and property damage.

Likelihood of other pathways: **Moderate**. The likelihood of silver carp entering the waters of the state via pathways other than golden shiner importation is listed as moderate. They can continue to move into state waters through connected waters. Their movement into other waters of the state is unlikely because of regulations in place and the lack of suitable spawning habitat throughout much of the state. However, they could be introduced by illegal movement of fish or contaminated wild harvested bait.

Northern Snakehead (*Channa argus*)

Certified by Arkansas: **Yes.** Northern snakehead are part of the Certification of Commercial Bait and Ornamental Fish Program in AR. Listed as an Injurious Species under Lacey Act[3].

Distribution in Arkansas: **Uncommon**. AR placed a ban on snakeheads in 2002. Prior to then no farm reared this species, however one farm did import some (Kelly Winningham, personal communication, 01/04/18). In 2008 a wild population of snakeheads was detected. Eradication was attempted, but the attempt failed at a cost of over US $750,000 (USFWS 2017). Snakeheads are found primarily in the Piney Creek watershed (AR ANS MP 2013), but are expanding their range and recently one was collected on the Mississippi side of the Mississippi River (Kelly Winningham, personal communication, 01/04/18). Because of the limited distribution throughout the state at this point they are listed as uncommon.

Distribution in Minnesota: **Not Detected**. Northern snakeheads have not been found in MN waters. Northern snakeheads are a prohibited species in MN[5].

Likelihood of transfer: **Low***.* Likelihood of being transported with golden shiners imported from AR is considered low because they are part of the AR certification program and their current established populations in AR are not near the majority of baitfish farms (Kelly Winningham, personal communication, 12/06/17).

Likelihood of establishment: **High**. Likelihood that snakeheads would become established in MN if they were introduced into state waters is considered high. Northern snakeheads have broad physiological tolerances and can adapt to a wide range of habitats including those of the northern U.S. and southern Canada (USGS NAS, December 2017; USFWS 2017).

Impact if established: **Severe***.* While currently unknown, impact of northern snakehead introductions into MN could be severe. Northern snakeheads are voracious predators that can adapt to a variety of habitats. They could compete with native fish for food and habitat.

Likelihood of other pathways: **Low***.* Northern snakeheads were likely introduced into several areas of the U.S. as unwanted animals by aquarists or consumers who purchased them in the aquarium or live seafood market. They were listed as injurious fish (as are 27 other species in the *Channidae* family) under the Lacey Act in 2002 and now cannot legally be imported into the U.S (National Control and Management Plan for Members of the Snakehead Family Channidae, 2014). They are not being legally sold in the aquarium or live food market, so the likelihood of northern snakehead or other members of that family being moved into MN waters is considered low. There have been illegal imports seized in 2010 and anglers could intentionally introduce snakeheads to new waters to create fishing opportunities (National Control and Management Plan for Members of the Snakehead Family Channidae, 2014) so the likelihood of other pathways may have to be reconsidered if northern snakehead continue to be found in new waters.

Western Mosquitofish (*Gambusia affinis*)

Certified by Arkansas: **No**. Western mosquitofish are not certified by the Certification of Commercial Bait and Ornamental Fish Program in AR.

Distribution in Arkansas: **Common**. Western mosquitofish are native to AR and are common.

Distribution in Minnesota: **Stray.** Western mosquitofish are not likely established in MN waters, however, USGS NAS, (December 2017) indicates populations were listed as established back in the 1950s and 60s. Western mosquitofish are a prohibited species in MN[5].

Likelihood of transfer: **Medium**. Western mosquitofish can be found on baitfish farms. There are best management practices in place that certified farms are recommended to follow (Circular 21) which reduces the risk of moving western mosquitofish with golden shiners, but the risk is still present and therefore is considered medium.

Likelihood of establishment: **Medium**. Western mosquitofish have been reported as established in MN waters, but, those reports were from the late 1950s and early 1960s (USGS NAS, December 2017). No current reports of them in Minnesota were found. They are not cold tolerant and would generally need ground water springs or other warmer water refuge to survive in MN (USGS NAS, December 2017). However, in the Western Mosquitofish Ecological Screening Summary (USFWS 2017b) it was concluded that there is no climate barrier to this species invading all of the U.S. Due to these contradictory assessments, I assigned a medium risk for establishment in Minnesota.

Impact if established: **Moderate**. Western mosquitofish are aggressive and can reduce native fish and invertebrates through predation and competition if they become abundant. It has also been reported mosquitofish can cause algal blooms by reducing zooplankton. Although widely distributed for mosquito control, western mosquitofish have not been effective in offering mosquito control or reducing mosquito-borne diseases (USGS NAS, December 2017). The Western Mosquitofish Ecological Screening Summary (USFWS 2017) concluded that their history

of invasiveness is high and that their negative impacts where they have been introduced around the world is well documented.

Likelihood of other pathways: **Low**. Likelihood that western mosquitofish could be introduced through other pathways is considered low, but there may still be some interest in using them as a mosquito control agent in private ponds where they could escape into other waters.

White Perch (*Morone americana*)

Certified by Arkansas: **No**. White perch are not certified by the Certification of Commercial Bait and Ornamental Fish Program in AR.

Distribution in Arkansas: **Uncommon**. White perch were likely part of a shipment of striped bass from VA which were stocked in KS. They likely moved downstream into the Arkansas River and were found in Arkansas waters of the river by 2006. They are considered invasive, a nuisance, and an ecological threat according to the AR ANS Management Plan (2013).

Distribution in Minnesota: **Uncommon**. White perch are present in MN only in the St. Louis River estuary, Lake Superior. White perch are a prohibited species in MN[5].

Likelihood of transfer: **Low**. Even though they are not part of the AR certification program, their likelihood of being transferred to MN via golden shiner harvest is considered low. Baitfish producers that are part of the certification program are only allowed to use well water and cannot bring any wild fish onto their farms.

Likelihood of establishment: **High**. The likelihood of establishment if white perch were to be introduced into additional MN waters is considered high. They have become established in the Great Lakes, the Mississippi, Missouri, Illinois, and Arkansas Rivers, several reservoirs and inland lakes where they have been introduced. White perch appear to do well in a wide variety of habitats (USGS NAS, December 2017).

Impact if established: **Severe**. White perch have shown that they can have severe negative impacts on native fish populations. White perch may be responsible for the collapse of the walleye fishery in the Bay of Quinte, the decline in yellow perch growth rate in Lake Erie, and declines in emerald and spottail shiners in Lake Erie (USGS NAS, December 2017). Because it has been shown to impact important MN species, its impact if established in uninfested waters is considered severe.

Likelihood of other pathways: **Moderate**. Likelihood of other pathways is considered moderate because white perch are established in the Mississippi River near the confluence with the Illinois River and could move into MN waters by moving upstream.

European Rudd (*Scardinius erythrophthalmus*)

Certified by Arkansas: **Yes**. European rudd are part of the Certification of Commercial Bait and Ornamental Fish Program in AR.

Distribution in Arkansas: **Stray**. According to USGS NAS (December 2017) rudd have been collected from three locations in AR prior to 1998 and their status is reported as failed (in one case the status was listed as unknown). Kelly Winningham (personal communication, 12/06/17)

indicated rudd are not cultured or found in AR now. Rudd are a restricted aquaculture species in AR[4] (AR ANS MP 2013).

Distribution in Minnesota: **Not Detected**. No rudd have ever been found in MN waters. Rudd are a prohibited species in MN[5].

Likelihood of transfer: **Low**. Likelihood of being transported with golden shiners imported from AR is considered low because they are part of the AR certification program and they are no longer found in AR.

Likelihood of establishment: **High**. If rudd were introduced into MN waters, it is highly likely they could become established. Rudd can be found in lakes, rivers, wetlands, and ponds. They prefer areas with little current and prefer large vegetated areas.

Impact if established: **Unknown**. The impact of the rudd's introduction is relatively unknown. Studies have shown that rudd hybridize with golden shiners (Burkhead and Williams 1991), which could have negative consequences. Rudd would likely compete with native fish for food. Rudd are omnivorous and seem to use more plant material in their diet than native species. There is little evidence to demonstrate that rudd, if establish in MN waters, would have widespread negative impacts. The impact if they become established in MN is therefore considered unknown.

Likelihood of other pathways: **Low**. Likelihood that rudd could enter MN through other pathways is considered low because they are not common in the bait or ornamental market and there are no established populations in connected waterways close to MN borders.

Goldfish (*Carassius auratus*)

Certified by Arkansas: **No.** Goldfish are not certified by the Certification of Commercial Bait and Ornamental Fish Program in AR.

Distribution in Arkansas: **Common**. Goldfish are reared as bait on farms that also rear golden shiners. Goldfish are sometimes marketed as "black salty." Black salty baitfish are just the wild, bronze colored goldfish that were marketed to saltwater fishermen. This was more of a marketing effort than creating a new strain of goldfish (Mark Stoll, personal communication, 12/11/17).

Distribution in Minnesota: **Uncommon**. Distribution of goldfish in MN is unknown (Nick Frohnauer, personal communication, 11/15/17). There are 47 records of goldfish being found in MN in the USGS NAS database (December 2017), but the status of nearly all is listed as unknown. Goldfish are a regulated species in MN[6].

Likelihood of transfer: **Medium**. The likelihood of goldfish being transferred to MN via importation of golden shiners is considered medium. Because goldfish and golden shiners are raised on the same farm and the same vats are used during harvest and loading trucks (at separate times) it might suggest the risk is high. In talking to fish farmers (Jamie Anderson, personal communication, 12/04/17) and AR certification program overseers (Dr. Anita Kelly, personal communication, 12/08/17 and Mark Stoll, 12/11/17), it is clear that farm management takes seriously their commitment to ensure the species are not mixed. Tanks are drained and

disinfected between every harvest. An argument could be made that this management practice may result in a low risk, but without observing the harvest to truck process, the risk is considered medium.

Likelihood of establishment: **Medium**. Even though there are 47 records of goldfish being found in MN waters and goldfish have been an ornamental fish for over 100 years (and likely released into the environment quite often), their status in MN is still unknown. They have not established large or nuisance populations in the state. Their likelihood of establishment is listed as medium, but may actually be low, based on past introductions. Even in states where goldfish are used for bait, nuisance populations do not appear to be established.

Impact if established: **Low**. Goldfish are one of the most widely distributed foreign fishes in North America, yet in most states they are not considered a nuisance species (USGS NAS, December 2017). For the most part, they have not demonstrated large visible populations that have impacted native fish. There are exceptions as reported in the USGS NAS species overview (December 2017). Their impact to MN waters is considered low because of their history of introductions and lack of large sustaining populations causing problems. There is a need to further study the potential impacts of goldfish in MN.

Likelihood of other pathways: **High**. Likelihood that they could be introduced to the state via pathways other than the importation of golden shiners is high. Goldfish are raised around the country for bait, feeder fish (to feed carnivorous ornamental fish), and ornamental fish. They could also move into state waters via connecting channels. Goldfish can be used for bait in IA (www.iowadnr.gov/Fishing/Iowa-Fish-Species/Fish-Details/SpeciesCode/GOF).

Asian Tiger Mosquito (*Aedes albopictus*)

Certified by Arkansas: **No**. Asian tiger mosquitoes are not certified by the Certification of Commercial Bait and Ornamental Fish Program in AR.

Distribution in Arkansas: **Fairly Common**. Asian tiger mosquitoes are fairly common in AR.

Distribution in Minnesota: **Stray**. According to an MPR report (August 4, 2016) Asian tiger mosquitoes have been found on 17 different occasions, but they are unlikely to overwinter in MN (CDC Fact Sheet 2017; www.cdc.gov/zika/vector/range.html). Because they haven't become established in MN their distribution is considered stray.

Likelihood of transfer: **Low**. Likelihood of transfer with golden shiners imported into MN is considered low. Asian tiger mosquitoes typically lay their eggs in natural and artificial containers such as tree holes, used tires, and other small water-holding containers (CDC Fact Sheet 2017). They would not typically lay eggs in fish production ponds. Even if Asian Mosquito larvae were to be found in vats or equipment used to harvest and load golden shiners on trucks, the loading process would likely exclude any invertebrate larvae. Golden shiners are graded in vats. The process of grading and netting golden shiners for loading onto trucks would likely separate baitfish from mosquito larvae.

Likelihood of establishment: **Low**. Asian mosquitos are not expected to overwinter in MN. According the Centers for Disease Control (CDC Fact Sheet 2017;

www.cdc.gov/zika/vector/range.html) the northern range of Asian tiger mosquitos is likely to extend only into northern Missouri and Central Illinois.

Impact if established: **Unknown**. Asian tiger mosquitoes tend to associate with humans (rather than living in wetlands) and typically feed in the daytime in addition to at dusk and dawn. Asian tiger mosquitoes are an important vector for the transmission of many viral pathogens, including yellow fever, dengue fever, and Chikungunya fever. They are capable of hosting the Zika virus and could transmit Zika virus disease to humans.

Likelihood of other pathways: **High**. Likelihood of Asian tiger mosquitoes entering the state through other pathways is listed as high because they are easily transported in used tires and other water-holding commercial products. Most of the locations where Asian tiger mosquitos have been found in MN have been commercial locations (MPR, August 4, 2016; www.mprnews.org/story/2016/08/04/health-officials-search-minnesota-for-zika-carrying-mosquito).

Non-Native Crayfish

Certified by Arkansas: **No**. Crayfish are not certified by the Certification of Commercial Bait and Ornamental Fish Program in AR.

Distribution in Arkansas: **Common**. At least 62 crayfish species are found in AR (Fetzner Jr. 2011). Two are likely of greatest concern for introduction into MN. The white river *(Procambarus acutus)* and red swamp (*Procambarus clarckii*) crayfish are common in AR and can invade fish production ponds. The crayfish most commonly found in golden shiner ponds is almost exclusively the white river crayfish. Red swamp crayfish are found further south in AR. Dr. Eric Park (personal communication, 1/15/18) said he has personally never seen a red swamp crayfish in baitfish production ponds although he said that it could happen. Rusty crayfish (*Orconectes rusticus*), already found in over 100 locations in MN, has not been found in AR.

Distribution in Minnesota: **Stray**. Neither crayfish species is known to be established in MN, however, red swamp crayfish were found in Tilde Lake, Clay County (USGS NAS, December 2017) and the white river crayfish was found in a Mississippi River backwater (Helgen 1990). Red swamp crayfish are a prohibited species in MN[5].

Likelihood of transfer: **High**. Crayfish are often seen in vats following golden shiner harvest and before transfer to trucks, but farmers try to make sure they are not loaded onto trucks (Mark Stoll, personal communication, 12/11/17). While farmers are vigilant and try to remove crayfish by hand and the grading / netting process, the likelihood of transfer is considered high because crayfish often escape detection and get loaded onto trucks. Golden shiners imported into VT have been found to contain crayfish and tadpoles (Adam Miller and Tom Jones, personal communication, 1/8/18). Dave Robinson (Robinson Wholesale Bait LLC) frequently sees crayfish in the golden shiners he brings into WI from AR (personal communication, 1/15/18). Dr. Eric Park (personal communication, 1/15/18) said that virtually every baitfish farm has crayfish and that at certain times of year a holding vat which may have 300 lbs. of golden shiners could have 10 to 25 lbs. of crayfish (almost exclusively the white river crayfish).

Likelihood of establishment: **High**. White river and red swamp crayfish may not establish nuisance populations in MN due to cold winter climate. However, according to the Red Swamp Crayfish Ecological Risk Screening Summary (USFWS 2015a) and the White River Crayfish Ecological Risk Screening Summary (USFWS 2015b), both species may be able to colonize every state in the contiguous U.S. Likelihood of establishment of both species of crayfish in MN waters is therefore, listed as high.

Impact if established: **Moderate**. White river and red swamp crayfish could compete with native crayfish species for food and habitat. They could negatively impact amphibian breeding success. They are known to consume fish eggs. Burrowing behavior can cause problems for banks and levees. They are known to impact commercial rice production. Impact on wild rice production in MN could be significant if they ever became established. Although not likely to survive winters where wild rice is grown, their impact if established is considered moderate (primarily because of wild rice threats). More information is needed to fully assess the risk that these two crayfish pose for MN waters.

Likelihood of other pathways: **Moderate**. These crayfish are raised and harvested for live food sale. They are also sold by the biological supply trade and may be released following classroom or laboratory study by teachers and students. They can also be sold in the aquarium trade. Regulations in MN reduce the likelihood of these pathways but not all border states have comparable protections in place and enforcement of internet sales is difficult.

Zebra/Quagga Mussels (*Dreissena polymorpha and D. rostriformis bugensis*)

Certified by Arkansas: **Yes**. Zebra and quagga mussels are part of the Certification of Commercial Bait and Ornamental Fish Program in AR. Zebra and quagga mussels are listed as Injurious Species under Lacey Act[3].

Distribution in Arkansas: **Fairly Common.** Quagga mussels have not been found in AR, but zebra mussels have been found in the Arkansas, Mississippi, St. Francis, and White Rivers (AR ANS MP 2013).

Distribution in Minnesota: **Fairly Common**. Zebra mussels are found in over 125 lakes in MN which is less than 1% of Minnesota lakes (MNDNR). Quagga mussels have only been found in Lake Superior, the St. Louis River estuary and in the Mississippi River (USGS NAS, December 2017). These are prohibited species in MN[5].

Likelihood of transfer: **Low.** It is unlikely zebra or quagga mussels would be transferred to MN in shipments of golden shiners from AR. The Arkansas Plant Board monitors certified farms for the presence of invasive mussels and none have been found on fish farms (Mark Stoll, personal communication, 12/11/17). In addition, certified baitfish farms in AR can only use ground water for filling ponds.

Likelihood of establishment: **High.** Based on the current distribution and establishment of zebra mussels in MN, the likelihood that they will become established if introduced to an uninfested waterbody is high. The likelihood of quagga mussels becoming established if introduced to uninfested waters of the state is also high.

Impact if established: **Severe.** Zebra and quagga mussels colonize hard surfaces and can impact power plants, water treatment facilities, recreational pursuits, and the environment. Invasive mussels can clog pipes, screens, and water intakes. They can colonize rocks and swim ladders and dead shells can wash up on beaches where swimmers and waders can cut their feet. They have severely impacted native mussels by attaching to their shells in numbers high enough to kill them. Both species filter phytoplankton from the water. Because they can attain such high densities, this filtering can alter food webs, reduce food available to larval fish, and cause declines in important fish species. Their water filtering can increase water clarity which can result in unwanted growth of rooted aquatic plants, harmful algal bloom and type E botulism in fish and waterfowl.

Likelihood of other pathways: **High.** Adult zebra and quagga mussels can survive out of water for a week or longer. Adults attached to boats or aquatic plants entangled on boats and can easily be moved to new waters. Larval mussels can be transported in water moved from an invested waterbody. Even though there are regulations and strong education programs in MN to reduce the likelihood of these pathways, given the current distribution in MN, there is a high likelihood that zebra and quagga mussels could be moved to uninfested waters.

New Zealand Mudsnails (*Potamopyrgus antipodarum*)

Certified by Arkansas: **Yes.** New Zealand mudsnails are part of the Certification of Commercial Bait and Ornamental Fish Program in AR.

Distribution in Arkansas: **Not Detected**. New Zealand mudsnails have not been detected in AR.

Distribution in Minnesota: **Stray**. New Zealand mudsnails were found in the St. Louis River Estuary, Lake Superior in 2005 (USGS NAS, December 2017). They have not been found anywhere else in MN. New Zealand mudsnails are a prohibited species in MN[5].

Likelihood of transfer: **Low**. It is unlikely New Zealand mudsnails would be transferred to MN in shipments of golden shiners from AR. The Arkansas Plant Board monitors certified farms for their presence and none have ever been found in AR.

Likelihood of establishment: **High**. Likelihood that they will become established if introduced to an uninfested MN waterbody is high. New Zealand mudsnails tolerate a broad range of aquatic conditions such as salinity, temperature, turbidity, water velocity, and stream productivity. They are adaptable to diverse climates. They inhabit lakes, rivers, streams, reservoirs and estuaries. (USGS NAS, December 2017).

Impact if established: **Severe.** Densities can reach up to 750,000 per square meter. They feed on algae, sediment, plant and animal detritus and can outcompete species that are important food for trout and other fish and provide little nutrition to fish that eat them. The result can be reduced growth rates and lower populations of important fish species. However, economic and ecological impacts have yet to be well documented (Casey 2009).

Likelihood of other pathways: **High**. New Zealand mudsnails spread easily on aquatic plants, waders, and other gear used in infested waters. They are able to close their shells, allowing them to survive out of water for days. They can easily start new infestations because they

reproduce without mating by cloning themselves. One snail and its offspring can form hundreds of thousands of clones per year. They can survive passage through the guts of fish and birds and therefore may be easily moved to uninfested waters (Casey 2009).

Eurasian Watermilfoil (*Myriophyllum spicatum*) (EWM)

Certified by Arkansas: **Yes**. EWM is part of the Certification of Commercial Bait and Ornamental Fish Program in AR.

Distribution in Arkansas: **Uncommon**. It is only found in Lakes Ouachita and Hamilton (USGS NAS, December 2017).

Distribution in Minnesota: **Common**. More than 350 lakes are infested with Eurasian watermilfoil in MN (MNDNR infested waters list). EWM is a prohibited species in MN[5].

Likelihood of transfer: **Low**. It is unlikely EWM would be transferred to MN in shipments of golden shiners from AR. The Arkansas Plant Board monitors certified farms for its presence and EWM is not found near baitfish farms in AR. In addition, the process of grading golden shiners and loading them onto trucks greatly reduces the risk of moving any plant material with baitfish.

Likelihood of establishment: **High**. Based on the current distribution and establishment of EWM in MN, the likelihood that it will become established if introduced to an uninfested waterbody is high.

Impact if established: **Severe**. EWM competes with and displaces native aquatic vegetation. It forms very dense mats of vegetation on the surface of the water. These mats interfere with recreational activities such as swimming, fishing, water skiing, and boating. Control costs are high in MN lakes that are infested.

Likelihood of other pathways: **High**. EWM is able to reproduce successfully and rapidly from plant fragments. Fragments will float to other areas, sink, and start new plants. A new plant can start from a tiny piece of a EWM plant. This is why EWM can so easily be transported from lake to lake on boat trailers or fishing gear. Even though there are regulations and strong education programs in MN to reduce the likelihood of these pathways, given the large number of lakes infested with EWM in Minnesota and nearby states, the likelihood that new waterbodies may be infested is considered high.

Hydrilla (*Hydrilla verticillata*)

Certified by Arkansas: **Yes**. Hydrilla is part of the Certification of Commercial Bait and Ornamental Fish Program in AR. Hydrilla is a USDA APHIS Federal Noxious Weed[7].

Distribution in Arkansas: **Uncommon**. Monoeisious hydrilla is present in a few AR lakes including Lakes Ouachita and Hamilton (AR ANS Management Plan and USGS NAS, December 2017). It is also reported in De Gray Lake, Millwood Lake, Calion Lakes and the Arkansas River (USGS NAS, December 2017).

Distribution in Minnesota: **Not Detected**. Hydrilla has not been found in MN. Hydrilla is a prohibited species in MN[5].

Likelihood of transfer: **Low**. It is unlikely hydrilla would be transferred to MN in shipments of golden shiners from AR. The Arkansas Plant Board monitors certified farms for its presence and hydrilla is only found in a few locations in AR. In addition, the process of grading golden shiners and loading them onto trucks greatly reduces the risk of moving any plant material with baitfish.

Likelihood of establishment: **Medium**. Research on the distribution of hydrilla in Asia predicts that hydrilla could colonize virtually any area in North America and could survive as far north as Hudson Bay (Haller Chapter 15.1; www.aquatics.org/bmpchapters/Chapter_15-01.pdf).

Impact if established: **Severe**. Hydrilla has become a severe problem in parts of the U.S. Hydrilla clogs drainage and irrigation canals, prevents boating access for fishing and other water recreation, impedes commercial navigation, shades out beneficial native plants, degrades water quality, restricts water movement, and interferes with hydroelectric plants and urban water supplies. The potential impact if established in MN depends on its ability to flourish in a cold climate.

Likelihood of other pathways: **High**. Hydrilla is mainly introduced to new waters as fragments on recreational boats, their motors and trailers. Fragments root in the substrate and develop into new colonies, commonly beginning near boat ramps. Once established, boat traffic continues to break and spread hydrilla throughout the waterbody. Hydrilla can also contaminate aquatic plant shipments ordered over the internet (www.seagrant.umn.edu/newsletter/2004/09/mailordering_aquatic_plants_can_be_dangerous.html).

Giant Salvinia (*Salvinia molesta*)

Certified by Arkansas: **Yes**. Giant salvinia is part of the Certification of Commercial Bait and Ornamental Fish Program in AR. USDA APHIS Federal Noxious Weed[7].

Distribution in Arkansas: **Stray**. Giant salvinia is found in Smith Park Lake in SW AR (USGS NAS, December 2017), far away from any baitfish farms. It is listed as a prohibited plant in AR[8] (AR ANS MP 2013).

Distribution in Minnesota: **Not Detected**. Giant salvinia has not been detected in MN.

Likelihood of transfer: **Low**. It is unlikely giant salvinia would be transferred to MN in shipments of golden shiners from AR. The Arkansas Plant Board monitors certified farms for its presence and giant salvinia is found only in one location in far SW AR. In addition, the process of grading golden shiners and loading them onto trucks greatly reduces the risk of moving any plant material with the baitfish.

Likelihood of establishment: **Low**. Giant salvinia prefers tropical, sub-tropical, or warm temperatures and grows best in nutrient-rich, slow-moving waters such as ditches, canals, ponds, and lakes. It cannot withstand ice formation on the water surface (Whiteman and Room 1991), so it is unlikely giant salvinia would become widely established in MN.

Impact if established: **Severe**. Thick floating mats can impede navigation, reduce water flow, interfere with fishing and recreational activities and shade out native plants. Decomposing plant

material can drop to the bottom, consuming dissolved oxygen needed by fish and other aquatic life.

Likelihood of other pathways: **High**. Giant salvinia can easily be transported from lake to lake on boats, boat motors, and trailers or fishing gear.

[1] **OIE reportable aquatic animal pathogen.** The United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) follows standards and rules in concert with the World Organization for Animal Health (Office of International Epizooties or "OIE"). As a member country, the United States monitors animal diseases from a list of "Notifiable diseases" that is generated by OIE (www.oie.int/animal-health-in-the-world/oie-listed-diseases-2018/). Any "notifiable animal diseases" that are detected in the U.S are reported to OIE.

[2] **Minnesota certifiable disease.** 2017 Minnesota Statutes 17.4982 DEFINITIONS. Subd. 6. Certifiable diseases in Minnesota include channel catfish virus, bacterial kidney disease, bacterial furunculosis, enteric redmouth disease, enteric septicemia of catfish, infectious hematopoietic necrosis virus, infectious pancreatic necrosis virus, whirling disease, proliferative kidney disease, viral hemorrhagic septicemia virus, epizootic epitheliotropic virus, ceratomyxosis, and any emergency disease (www.revisor.mn.gov/statutes/?id=17.4982). Intrastate transportation of aquatic life between or within licensed private fish hatcheries, aquatic farms, or aquarium facilities licensed for the species being transported, except where required in subdivision 2 and except that salmonids, catfish, or species on the official list of viral hemorrhagic septicemia susceptible species published by USDA APHIS, may only be transferred or transported intrastate without a transportation permit if they had no record of bacterial kidney disease or viral hemorrhagic septicemia at the time they were imported into the state and if they have had a fish health inspection within the preceding year that has shown **no certifiable diseases** to be present.

[3] **Injurious Species under Lacey Act.** The Lacey Act (18 U.S.C. 42) authorizes the Secretary of the Interior to prohibit the importation and shipment of injurious species (www.fws.gov/injuriouswildlife/pdf_files/Current_Listed_IW.pdf) between the continental United States, the District of Columbia, Hawaii, the Commonwealth of Puerto Rico, or any possession of the United States of species, including offspring and eggs, designated through regulation to be injurious to the health and welfare of humans, the interests of agriculture, horticulture or forestry, and the welfare and survival of wildlife resources of the United States.

[4] **Arkansas Restricted Aquaculture Species.**
The permitted culture of any restricted aquaculture species shall be conducted in a responsible manner that minimizes the possibility of escape (www.anstaskforce.gov/State%20Plans/Final_Arkansas_ANS_Mgmt_Plan_July_2013.pdf). Permitted aquaculturists are required to construct a barrier that prevents escape of juvenile and adult fishes from culture ponds. Pond drainpipes should be double screened prior to any pond drainage with at least one screen being of a mesh size small enough to prevent the passage of any permitted fish present in the pond. These and any other measures listed on the application to eliminate the possibility of escape will be considered the "best management practices" that the applicant agrees to implement. AGFC will maintain records of the number and location of these species in the state, and determine if sufficient

precautions are taken to prevent escape into the waters of the state. AGFC will review applications based on the best information available to evaluate the potential for escape. If this potential is acceptably low, the Chief of Fisheries will grant a no-cost special holding permit for these species, renewable annually. In the event that restricted aquatic organisms are released or escape from a permitted facility into waters of the state, the permitee shall notify the Arkansas Game & Fish Commission (AGFC) immediately.
Species covered by these permits include:

European rudd (*Scardinius erythrophthalmus*)
Diploid black carp (*Mylopharyngodon piceus*)
Silver carp (*Hypophthalmichthys molitrix*)
Bighead carp (*Hypophthalmichthys nobilis*)

[5] **Minnesota prohibited invasive species.** Certain invasive species that can threaten natural resources and their use have been designated as prohibited invasive species in Minnesota (www.revisor.mn.gov/rules/?id=6216.0250). It is unlawful (a misdemeanor) to possess, import, purchase, transport, or introduce these species except under a permit for disposal, control, research, or education.

[6] **Minnesota regulated invasive species.** It is legal to possess, sell, buy, and transport regulated invasive species, but they may not be introduced into a free-living state, such as being released or planted in public waters (www.revisor.mn.gov/rules/?id=6216.0260).

[7] **Federal noxious weed.** The Secretary of Agriculture was given the authority to designate plants as noxious weeds by regulation, and the movement of all such weeds in interstate or foreign commerce was prohibited except under permit (www.aphis.usda.gov/plant_health/plant_pest_info/weeds/downloads/weedlist.pdf). The Secretary was also given authority to inspect, seize and destroy products, and to quarantine areas, if necessary to prevent the spread of such weeds.

[8] **Arkansas prohibited plant list.** Plants on this list present a danger to the natural ecosystem in Arkansas and are declared prohibited plants (http://nationalplantboard.org/wp-content/uploads/docs/summaries/arkansas.doc). No plant, seed or reproductive structure may be sold or utilized in plantings in Arkansas. The following plants are on this list.

1. Purple Loosestrife (*Lythrum salicaria*)
2. Giant Salvinia (*Salvinia molesta*)
3. Water Hyacinth (*Eichornia crassipes*, *E. azurea*)
4. Japanese Blood Grass (*Imperata cylindrica*)

Reducing the Risk of Moderate to High Risk Organisms

The following is a further discussion of the risks posed by the five organisms selected through the risk assessment matrix (APPENDIX A) and risk assessment matrix justification.

- Asian Tapeworm (*Schyzocotyle acheilognathi*)

- Golden Shiner Virus
- Ovarian parasite (*Ovipleistophora ovariae*)
- Western Mosquitofish (*Gambusia affinis*)
- Non-native Crayfish (*Procambarus acutus* and *P. clarkii*)

Asian Tapeworm (*Schyzocotyle acheilognathi*)

The Asian tapeworm is a fish parasite that originated from eastern Asia. It is a generalized parasite that particularly affects cyprinids but over 200 fish of different families have been found to serve as hosts (Scholz 2012). Asian tapeworm has been introduced nearly worldwide, mainly with shipments of live grass carp. Asian tapeworms can have pronounced detrimental effects on fish, including severe damage to the intestinal tract, physiological disturbance, reduced growth, condition loss and death.

Fish infections can be detected at autopsy, with recovery of entire tapeworms followed by microscopic examination of the scolex. The presence of Asian tapeworms may also be determined by a squash plate method. Glass slides or plates are used to flatten the intestinal tract and the worms are detected by reflected light and low-power microscopy.

The life cycle of the Asian tapeworm involves an intermediate host and the definitive host. Eggs are passed in the feces of the fish host and coracidia hatch in 1–5 d depending on water temperature. Free-swimming coracidia are ingested by cyclopoid copepods, the intermediate host. Hexacanths develop into infective procercoids in 11–12 d. The life cycle is completed when a fish eats an infected copepod and the procercoids develop into adult tapeworms. Transmission of adult tapeworms can also occur when a fish consumes an infected fish (Muzzal et al. 2016). Therefore, Asian tapeworms can be moved to new waterbodies with the movement of fish or water with infected copepods or free-swimming coracidia. Asian tapeworms are likely moved from one waterbody to another with baitfish. Boonthai et al. (in press) surveyed 78 retail bait shops in Michigan. They detected Asian tapeworm throughout Michigan in 48 of 90 (53.3%) lots examined. The tapeworm was found in emerald shiners, golden shiners and sand shiners.

Asian tapeworms are fairly common in AR and have been found in farm-raised golden shiners. While some farms are free from Asian tapeworms and are certified by the AR certification program as Asian tapeworm-free (APPENDIX C), other farms have the tapeworm and have stopped shipping golden shiners to states like California which require imported bait to be free of Asian tapeworms (Jamie Anderson, personal communication, 12/04/17).

Little information is available on impacts of Asian tapeworm on wild fish populations. Asian tapeworms have not caused any problems in wild WI fish populations where golden shiners have been imported as bait for over 20 years (Dr. Myron Kebus, personal communication, 12/19/17). There is, however, greater concern in MI regarding how the spread of Asian tapeworms may impact wild forage fish populations (Muzzal et al. 2016 and Gary Whalen, personal communication, 12/21/17). In addition, Asian tapeworms are causing problems in wild fish populations in Europe (Dr. Mohamed Faisal, personal communication, 12/22/17).

Reducing the risk of introduction via golden shiner importation:

- Require golden shiners to be free of Asian tapeworms and verified by the AR certification Program.

- Require a two year (or longer) Asian tapeworm-free record.
- Require that anyone receiving imported golden shiners in MN keep records that show the fish have a certification and that the certification was checked upon receipt of the fish (using an AIS-HACCP-like record keeping system.
- Require annual testing for Asian tapeworms in golden shiners imported from AR at facilities in MN.

Research Needs:

- Determine if Asian tapeworms infect baitfish or wild populations of fish in Minnesota waters.
- Determine if Asian tapeworm-infected wild fish are experiencing population level impacts.
- Because carps are known carriers of Asian tapeworm, the silver and bighead carp moving into MN waters should be examined to see if they are infected and bringing Asian tapeworms into the state.

Ovarian Parasite (*Ovipleistophora ovariae*)

O. ovariae is a microsporidian parasite primarily of golden shiners, but has also been found in fathead minnows. It is a parasite that infects the ovaries and can reduce fecundity and cause sterility of farm-raised golden shiners. While *O. ovariae* will cause egg mortality, there is no evidence that *O. ovariae* causes mortality in other life stages. *O. ovariae* is widespread in farmed golden shiners throughout the country. It was found in 45 golden shiner farms in 12 states in 1970 (Summerfelt and Warner 1970b). It was also recently found in 56% of golden shiners collected from Minnesota bait shops (Dr. Nicholas Phelps, personal communication, 12/04/17).

O. ovariae was selected as a risk to Minnesota because it is likely to be transferred with imported farm-raised golden shiners, it could have significant impacts on golden shiner reproduction and it is likely to become established in waters with golden shiners (if they are not already infected). There is, however, little known about the effects of this parasite in the wild. The only record of *O. ovariae* in feral golden shiners is from a creek and a pond in the same watershed in Payne County, OK (Summerfelt and Warner 1970b). Golden shiners have been imported into WI for over 20 years and no apparent disease outbreaks of *O. ovariae* have occurred (Dr. Myron Kebus, personal communication, 12/19/17). There was also a significant illegal importation of golden shiners into Minnesota (Dennis Anderson 2008), most likely infected with *O. ovariae*, for many years and no wild population impacts have been reported. Golden shiner fish farms in Arkansas have gotten around the problem of reduced fecundity caused by *O. ovariae* by selecting age one fish (which have a lower incidence of infection) for broodfish.

A common concern is that a predatory fish could acquire an infection after consuming an infected golden shiner. The majority of microsporidia are host specific and there is no evidence to support that concern (Summerfelt and Goodwin 2010).

Transmission of *O. ovariae* is both horizontal and vertical. Horizontal transmission begins when a fish ingests viable spores that were discharged from spawning of infected fish. Fish could become infected by feeding on cladocera or copepod nauplii that consumed spores. Phelps and Goodwin (2008) provided evidence for vertical transmission with positive PCR for *O. ovariae* in fertilized eggs and in fry produced

from infected broodfish. Therefore, the parasite can be transferred with infected fish, infected eggs and in water.

To understand the risks posed to Minnesota golden shiners by the importation of infected Arkansas golden shiners the current incidence of the disease in Minnesota needs to be assessed and the impact to wild populations must be determined.

Reducing the risk of introduction via golden shiner importation:

- There may not be a way to import golden shiners from Arkansas that are free of *O. ovariae*.

Research Needs:

- Determine occurrence of *O. ovariae* in wild golden shiner populations in MN.
- Further examine the occurrence of *O. ovariae* in the MN bait supply and in golden shiner production ponds.
- Determine if *O. ovariae* has had population level impacts in wild golden shiners anywhere that it has invaded.
- Develop a more detailed risk assessment to determine *O. ovariae* potential impacts to farm-raised and wild golden shiners in Minnesota.

Golden Shiner Virus (GSV)

Golden Shiner Virus (GSV) is a reovirus that was first detected in 1977 in golden shiners at an Arkansas hatchery (Goodwin et al. 2006). The GSV is actually the Chinese grass carp reovirus (McCann 2012). It causes significant mortality in grass carp. In the U.S., GSV has been found in golden shiners, fathead minnows, creek chubs, white suckers, emerald shiners, muskellunge, silver carp, and smallmouth buffalo (McCann 2012). The pathogenicity of GSV doesn't seem to be well understood because expert opinions vary. According to Dr. Nicholas Phelps (personal communication, 12/04/17) pathogenicity of GSV is very low and GSV rarely causes mortality. His opinion was also expressed in a letter he provided from Dr. Andy Goodwin. Dr. Goodwin concluded that "during my 10 years at UAPB, there has not been even one case of shiner or fathead minnow mortality in AR that we attribute to GSV. It seems extremely unlikely that there are significant GSV negative areas in the US." However, in a study where fathead minnows were experimentally infected with GSV, there was a clear association between mortality, clinical disease and GSV (McCann 2012).

Dr. Mohamed Faisal (personal communication, 12/22/2017) expressed concern over the risk GSV posed for Muskellunge. He indicated that GSV was pathogenic to muskellunge in hatcheries. He did not know of mortalities in wild muskellunge but he has found GSV in a wild muskellunge. He suggested GSV should be considered a moderate risk. He indicated that if he were rating the risk posed by several viruses on a scale of 1 to 10 and VHS virus was a 10, then fathead minnow nidovirus would rank 7.5 and GSV would rank 4.5.

In a study by McCann (2012), baitfish from AR, MN and SD were tested for the presence of GSV, fathead minnow nidovirus, and other unknown viruses. In combined lots from the three states, thirty-six of the 82 lots (44%) of fish tested positive for one or more viruses. McCann (2012) found that 41% of golden

shiner lots, 32% of fathead minnow lots, and 5% of white sucker lots tested positive for GSV. Of the lots that tested positive for GSV, about half contained fish that displayed clinical signs: gill lesions and hemorrhages of the fin bases, vents, gill opercula, eyes, and skin. Clinical signs of GSV were seen in fathead minnows, golden shiners, and white suckers.

Due to the unknown risk to wild muskellunge and the clinical signs in several common baitfish, I ranked the potential impact as moderate rather than low. While the AR baitfish certification program will certify golden shiners as GSV-free, not all farms are free of the virus. For this reason, the risk of GSV being transported with golden shiners was considered medium.

McCann (2012) found that 59% of the lots of fish from AR, 44% from MN and 38% from SD were positive for one or more viruses. McCann (2012) also found that 47% of cultured baitfish and 31% of wild baitfish were positive for one or more viruses. She did not describe which baitfish she examined came from which of the three states and she lumped together GSV, FHMNV and unknown viruses in this analysis. What this suggests, however, is that the baitfish supply, even from MN, already is likely infected with GSV and other viruses. FHMNV was found in 8% of fathead minnow lots in her study. This raises a concern that MN baitfish may be infected with FHMNV to a greater extent than previously known.

Reducing the risk of introduction via golden shiner importation:

- Require golden shiners to be free of GSV and verified by the AR certification Program.
- Require a two year (or longer) GSV-free record for an AR fish farm to import golden shiners into Minnesota.
- Require that anyone receiving imported golden shiners in MN keep records that show the fish have a certification and that the certification was checked (and who checked it) upon receipt of the fish (using an AIS-HACCP-like record keeping system.
- Require annual testing at MN facilities for GSV in golden shiners imported from AR.

Research Needs:

- Determine the extent that GSV infects baitfish or wild fish populations in MN waters.
- Examine common baitfish carriers of GSV: golden shiners, fathead minnows, white suckers, emerald shiners and creek chubs.
- Determine if GSV-infected wild fish are experiencing population level impacts.
- Specifically look for GSV in wild and hatchery raised muskellunge in MN.

Western Mosquitofish (*Gambusia affinis*)

The western mosquitofish is a freshwater fish in the family *Poeciliidae*, native to the Mississippi River and its tributary waters from southern Indiana and Illinois to the Gulf Coast and parts of northeastern Mexico. They are hardy to a variety of temperatures, salinities and oxygen levels and have been spread through many parts of the world through introductions attempting to control mosquito populations. They are most common in vegetated ponds and lakes, backwaters and quiet pools of streams. They feed on zooplankton, small insects, detritus, fish eggs, and small fish (Nico and Fuller 2005; USFWS 2017b). Mosquitofish are voracious, aggressive predators that have extirpated or caused declines in many native

fish species (USFWS 2017b). Mosquitofish are small; females reach an overall length of 7 cm (2.8 in) and males at a length of 4 cm (1.6 in).

Several times a year mosquitofish produce moderate numbers of young, which are protected by the mother but which become immediately independent. Brood size is usually around 60 young, but large females can carry more than 300. Females can store sperm from one copulation and fertilize several broods sequentially. After a gestational period of 21 to 28 days, the young are born alive. Under optimal conditions males mature in 4 weeks and females mature in 6 weeks of age and produce 2-3 broods in their first summer (USFWS 2017b).

Mosquitofish were likely stocked into Minnesota waters for mosquito control. The only records of them in Minnesota are from collections made in the 1950s and 60s. They were primarily found in ponds located in Hennepin, Washington, Scott, and Ramsey counties (USGS NAS, December 2017). The status of the populations in many of those ponds is listed as established, but it is unknown whether populations of mosquitofish still persist in Minnesota. Mosquitofish are not thought to be cold tolerant and unlikely to become established in northern states (Nico and Fuller 2005), however, the western mosquitofish ecological screening summary (USFWS 2017b) concludes that the climate match for western mosquitofish was high for almost the entire continental U.S. With high certainty, they believe there is no climate barrier to this species invading the rest of the U.S.

Baitfish farmers under the Commercial Bait and Ornamental Fish Certification Program in AR apply BMPs to prevent western mosquitofish from getting into their ponds (Circular 21 2010), but it can happen. The occurrence of western mosquitofish in baitfish production ponds is low (Dr. Eric Park, personal communication, 1/15/18). He said that because western mosquitofish are so prolific and will drastically reduce baitfish production, fish farmers will drain ponds and sterilize any remaining water if western mosquitofish are found. Jamie Anderson (personal communication 1/22/18) said that mosquitofish are obvious and easy to see when they get into a pond. When they are found, the pond is immediately quarantined and then drained. If there are market-size golden shiners in that pond, they are shipped to states like Texas that don't have restrictions on mosquitofish. According to Anderson, they make sure that golden shiners going to states that prohibit mosquitofish are free of them. Because mosquitofish are smaller than market size golden shiners, they can also be removed through the grading process.

Western mosquitofish are dealt with using BMPs rather than the certification program because their presence is more likely to occur than that of the other species that are certified. One control method that reduces their presence in loads of baitfish is that they tend to die if liquid oxygen is provided. While they can survive very low oxygen levels, they do not survive well in high oxygen levels (Dr. Eric Park, personal communication, 1/15/18). This can be applied in the trucks that haul fish from the pond to the shed and in trucks hauling fish to market.

The risk of establishing western mosquitofish in waters of northern states through importation of golden shiners from Arkansas may be rather low, otherwise states like Michigan and Wisconsin where golden shiners have been imported for over 20 years would see established populations of mosquitofish. The only locations in those states where mosquitofish have been found (GLANSIS, December 2017) are the result of intentional stocking for biocontrol. Western mosquitofish were highlighted in this report as a potential risk to Minnesota waters because they are occasionally found on golden shiner farms, they are a prohibited species in Minnesota, and even though they are listed as not a cold tolerant species, the

Western Mosquitofish Ecological Screening Summary (2017b) concludes that there are no climate barriers in the contiguous U.S.

Reducing the risk of introduction via golden shiner importation:

- Require shipments of golden shiners into Minnesota from Arkansas be free of western mosquitofish.
- Require notification if western mosquitofish are found on golden shiner farms that are importing golden shiners into Minnesota.
- Because western mosquitofish are small, only allow the size of golden shiners to be imported that would easily allow mosquitofish to be graded out of the shipment if they happened to be present.
- Require imported golden shiners to be offloaded at a facility in Minnesota before they are delivered to retail outlets or other distributors. Require removal of mosquitofish by grading and observation.

Research Needs:

- Determine the frequency of western mosquitofish contaminating golden shiner shipments.
- Determine what grader size would screen out mosquitofish if they were present.
- Survey other northern states (MN, MI, VT for example) to see if they ever see mosquitofish in shipments of golden shiner from AR.

Non-Native Crayfish, Red Swamp Crayfish (*Procambarus clarckii* and *P. acutus*)

The two most likely crayfish to be found in baitfish production ponds are the white river (*P. acutus*) and the red swamp crayfish (*P. clarkii*). White river crayfish more likely to be found in production ponds. Dr. Eric Park (personal communication, 1/15/18) said he has personally never seen a red swamp crayfish in baitfish production ponds, although he said that doesn't mean it couldn't happen. White river crayfish are native to the area of Arkansas where baitfish are grown, while red swamp crayfish have a more southern Arkansas distribution.

Red swamp crayfish are native to Gulf Coast and Mississippi River drainage to Illinois. They have spread to other U.S. waters probably through the release of live study specimens by teachers and students, by aquarists as pets, by consumers who purchased them from live food markets and by anglers using them as bait. They are widely available in the U.S. through the seafood industry, aquarium trade, and biological supply houses. Both species live in a variety of freshwater habitats, including rivers, lakes, ponds, streams, canals, seasonally flooded swamps and marshes, and ditches. Generally, thought to be species of the southern U.S., they both may be able to colonize every state in the contiguous U.S according to the White River Crayfish Ecological Screening Summary (USFWS 2015b) and the Red Swamp Crayfish Ecological Risk Screening Summary (US FWS 2015a).

There are reported reproducing populations of red swamp crayfish in the Netherlands, Germany, Italy, and Switzerland suggesting they can adapt to cooler climates. They have also established populations in Lakes Erie and Michigan (USGS NAS December 2017), and more recently inland waters of OH and MI

(Doug Jensen, personal communication, January 9, 2018). A reproducing population of red swamp crayfish was also reported in a 6-acre pond in Washington County, WI in 2009.

Both species feed heavily on snails, fish, amphibians, and plants. They could compete with native crayfish for food and habitat. They could negatively impact amphibian breeding success. They are known to consume fish eggs. Burrowing behavior can cause problems for banks and levees. They are known to impact commercial rice production. Impact on wild rice production in MN could be significant if they ever became established in areas of the state where wild rice grows naturally or is cultivated. A native burrowing crayfish (*Orconectes immunis*) has already been shown to have devastating impacts on cultivated wild rice production (Richards et al. 1995). Eradicating white river and red swamp crayfish is nearly impossible because they often dig deep burrows into banks of lakes and rivers. The overall risk for white river crayfish (*Procambarus acutus*) is listed as unknown (USFWS 2015b). The risk posed by red swamp crayfish is considered high (USFWS 2015a). Red swamp crayfish are a prohibited species in MN while the white river crayfish are unlisted. Even though white river crayfish are the most common crayfish seen in golden shiner production ponds and are not considered as invasive as red swamp crayfish (USFWS 2015b), their presence in golden shiner shipments is still considered a risk to Minnesota waters. Whatever efforts are put in place to control white river crayfish will also control red swamp crayfish.

Crayfish are often seen in vats following golden shiner harvest and before transfer to trucks, but farmers try to make sure they are not loaded onto trucks (Mark Stoll, personal communication, 12/11/17). While farmers are vigilant and try to remove crayfish by hand and the grading / netting process, the likelihood of transfer is considered high because crayfish often escape detection and get loaded onto trucks. Golden shiners imported into VT have been found to contain crayfish and tadpoles. (Adam Miller and Tom Jones, personal communication, 1/8/18). Dave Robinson (Robinson Wholesale Bait LLC) frequently sees crayfish in the golden shiners he brings into WI from AR (personal communication, 1/15/18). Dr. Eric Park (personal communication, 1/15/18) said that virtually every baitfish farm has crayfish and that at certain times of year a holding vat which may have 300 lbs. of golden shiners could have 10 to 25 lbs. of crayfish (almost exclusively the white river crayfish). According to Dr. Eric Park, crayfish are most likely to be seen from March to July. Crayfish are not seen during the winter months.

Given that WI has imported baitfish from AR for over 20 years and there are no reports of white river crayfish and only one report of red swamp crayfish in the state (which was likely not the result of contaminated bait) suggests the risk could be considered relatively low.

There are at least five opportunities to reduce the risk for non-native crayfish to get into the waters of the state. Crayfish can be removed during on-farm grading and loading of the transport truck. Crayfish can be removed by the grading and loading process at the destination state holding facility. Crayfish can be removed by retail bait dealers. Educated anglers can prevent any release of non-native crayfish if crayfish were found in their bait. Finally, restricting importation of golden shiners into Minnesota to winter months when crayfish are unlikely to be found in shipments.

Reducing the risk of introduction via golden shiner importation:

- Importing golden shiners that have been graded in AR and then off-loading them into a Minnesota holding facility and grading them again before delivery to retail outlets would further reduce the risk of moving crayfish.

- Observation and hand removal in AR when golden shiners are loaded onto trucks, at holding facilities in the destination state, and at retail outlets will reduce the risk of non-native crayfish getting into uninfected waters.
- Allow importation during the time of year when golden shiner market demand is highest and crayfish contamination is lowest i.e. November to the end of February.
- AIS-HACCP plan developed specifically for the crayfish risk.
- Angler education aimed at getting anglers to destroy any non-target organisms in their bait and not release any unused bait into the wild would also help reduce the risk of non-native crayfish introduction.

Research Needs:

- Develop procedures for separating crayfish from fish.
- Determine if importing golden shiners from November to the end of February would eliminate the risk of crayfish contamination.
- Determine if there are areas of MN where climate may restrict white river and red swamp crayfish establishment.

Personal Communication Regarding Golden Shiner Importation

Market Demand and Importation Ban

The availability of golden shiners for bait in Minnesota has declined dramatically and consumer demand far outweighs production capacity in Minnesota. Marshall Koep (personal communication, 12/4/17) estimates that 5,000 to 10,000 gallons (40,000 to 80,000 lbs.) are needed to meet consumer demand. Denny Fletcher (personal communication, 1/22/18) thinks the excess demand is closer to 3,000 to 4,000 gallons (24,000 to 32,000 lbs.). Market demand is greatest from the start of ice fishing until the end of February (Denny Fletcher, personal communication, 1/22/18). One cause for the decline in golden shiner production in Minnesota may be the loss of production ponds/lakes. Increased land development may decrease access to ponds. Other causes of decline include introduction of predatory fish like walleyes, introduction of unwanted species like bullheads, and lack of winterkill. Marshall Koep, Urbank Live Bait Co. (personal communication, 12/04/17) said that they used to have 250 ponds/lakes to raise a variety of baitfish but now only have access to 60. His ponds specifically used for raising golden shiners have declined from around 30 to only four and the ponds currently available do not produce as much as the larger ponds/lakes they used to access. Denny Fletcher, a golden shiner producer in Minnesota said that 75% of the ponds he has access to are not usable because of unwanted fish in them (personal Communication 1/22/18). The MN DNR estimates that between 6,000 and 10,000 gallons (48,000 to 80,000 lbs.) of golden shiners are annually harvested in the state.

Another change that resulted in lower availability of golden shiners was a reduction in illegal importation. Although the extent of this illegal importation will likely never be known, significant numbers of golden shiners from Arkansas illegally found their way into Minnesota bait shops (Dennis Anderson 2008). There was an increased enforcement effort to prevent importation of baitfish into Minnesota when viral hemorrhagic septicemia (VHS) was found in the Great Lakes region. The increased

enforcement greatly reduced golden shiners from entering the state, contributing to the market shortage (Dennis Anderson 2008).

The initial ban on importing baitfish into Minnesota was in large part driven by the industry to protect Minnesota producers from competition (Dennis Anderson 2008). This original importation ban may have been unconstitutional and a violation of the commerce clause of the U.S. Constitution. The commerce clause restricts the power of states to enact laws and regulations that burden or interfere with interstate commerce.

But before any challenge to the Minnesota importation ban, the likelihood that aquatic invasive species (AIS) or fish pathogens could be transferred with live bait became recognized as a risk to the state. Therefore, rather than economic protectionism, the baitfish importation ban became a resource protection concern that would likely stand up in court as it did in Maine. The state of Maine was challenged for their ban on importing live baitfish and successfully used the argument that the ban was in place to protect the unique natural resources of the state (Maine v. Taylor). The federal Supreme Court found that the Maine law prohibiting the importation of out-of-state bait was constitutional.

Not all Minnesota bait dealers want to see golden shiners imported into Minnesota. Denny Fletcher thinks importing golden shiners is a bad idea because of the impact it would have on Minnesota golden shiner producers and because imported golden shiners could bring detrimental organisms with them (Dennis Fletcher, personal communication, 1/22/18).

Comments Regarding the AR Certification Program

Dr. Anita Kelly (Associate Director of the Aquaculture/Fisheries program at the University of Arkansas-Pine Bluff) oversees fish pathogen testing. She said that in addition to USDA APHIS inspection and testing every two years (APPENDIX B), the University of Arkansas Pine Bluff – Lonoke Fish Health Inspection Lab also is tested annually when samples are sent to them by the National Veterinary Services Lab in Ames, Iowa. Dr. Kelly indicated that several other pathogens and parasites will be certified if requested including fathead minnow nidovirus, *Heterosporis*, golden shiner virus, Asian tapeworm, koi herpes virus, *Edwarsiella tarda*, and largemouth bass virus. As an example, she provided a sample report for the state of Michigan (APPENDIX C). She asserted that baitfish ponds in Arkansas rarely flood. To her knowledge, only one has flooded and it was not part of the Arkansas certification program. If flooded, the ponds would have to be drained and the farm could be pulled from the certification program until they had a two-year history of being pathogen free. She also stated that some states require a three-year history of negative testing and many within the certification program have a 10-year history (Dr. Anita Kelly, personal communication, 12/08/17).

Regarding the risk posed by furunculosis and enteric redmouth disease, Dr. Anita Kelly stated, “Neither furunculosis nor enteric redmouth disease has been found in farmed fish we inspect in Arkansas. I have not heard of it in the state but that does not mean it is not here. We do bacterial tests for both of those diseases so it would be one that is routinely done regardless if the state asks for it. We do bacterial testing on all fish (unless asked not to). If bacteria grow on the plates we identify any primary bacterial pathogens that are of concern” (Dr. Anita Kelly, personal communication, 12/15/17).

Mark Stoll (Arkansas State Plant Board, a division of the Arkansas Agriculture Department, the official certifying agent of the certification program) explained that they charge $1/surface acre for the certification program. They go out to inspect ponds on farms each year. They spend 1-2 days inspecting half the ponds on the farm. Every pond is examined every two years. He said that additionally, inspectors will examine suspicious plants in any ponds and will look at the hatchery and fish in vats regardless of their pond of origin. So while ponds get a thorough examination every other year, actually they are examining more than half the farm each year. Stoll indicated that flooding is rare, but one farm, not yet part of the certification program, had a flooding event. The pond was drained and started over. The flooded pond was marked on the inspection sheet and double checked for invasive species. Stoll said that if sport fish like largemouth bass, catfish, bluegill, etc. are raised on the farm, they are completely separated. The holding sheds, vats, and other equipment must be kept separate. Because goldfish are part of the certification program, the same sheds, and vats can be used for them that are used for golden shiners. He said that vats are completely drained and cleaned between shipments so the cross contamination risk is low. When asked about the black salty, Stoll said black salty baitfish are just the wild, bronze colored goldfish that were marketed to saltwater fishermen. His opinion was that this was more of a marketing effort than creating a new strain of goldfish. He went on to say that he is not sure farmers are still raising them. Stoll said that he has not found a mosquitofish through his inspections. Farms must follow the BMPs for mosquitofish described above. He did say that sometimes crayfish are seen in the vats prior to loading trucks, but that they try very hard to not load them onto trucks. He said they don't have problems with participants in the program. The program is voluntary and the farmers participate because they want to be in the program and want to ensure their product and their reputation remains clean. Another thing Stoll described is that farms have one permit (that must be renewed annually) that may list various sport fish, ornamental fish and baitfish, but often those portions of the farms raising different species may be separated by miles. In other words, different species might not be raised at the same location even though they are listed on the same permit (Mark Stoll, personal communication, 12/11/17).

Kelly Winningham (AGFC Pathologist) was asked about the two additional pathogens. Her response relates to both the AR certification program and the use of wild bait. "I have seen furunculosis (*Aeromonas salmonicida*) in trout in our hatchery systems and enteric redmouth (*Yersinia ruckeri*) in our trout at the hatchery but have not isolated either of these pathogens from warm water species. We actually vaccinate the trout at our hatchery for enteric redmouth. I would suspect both of these pathogens are present in Minnesota already. In Arkansas trout are not permitted to be used as bait, additionally, we also have no private producers of trout in Arkansas. To my knowledge, in cases where *Aeromonas salmonicida* have been isolated in warm water species they are usually atypical and not the ones that cause furunculosis. I am curious about the pathogen detection process, if you are already detecting these pathogens in samples pulled from your current bait used in the state, then the risk for farm reared bait that is inspected twice a year for pathogens and has AIS inspections should actually minimize risk compared to what you already are detecting and utilizing as a bait source. Fish farms that are in the baitfish certification program must use well water. In my experience with Minnesota bait over the years, most of it has been wild caught bait, which is a huge risk. As a matter of fact, starting October 2018, Arkansas has a regulation that will limit the use of wild caught bait by restricting wild caught bait usage to the waterbody where the bait was taken. Bait cannot be moved above a dam either, even if it is the same system. This is to minimize the risk of spreading AIS in the state. I would really have great concern with the selling of wild caught bait across the state, because a waterbody with wild caught fish

cannot be disease free certified and if you pull a sample from it you are only getting the snapshot for that day. In the farm reared situation here you have captive brood, well water, no anglers, and farm level inspections for disease occurring twice a year to specifically minimize risk." (Kelly Winningham, personal communication, 12/15/17).

Dr. Myron Kebus (WI DATCP Aquaculture Veterinarian) indicated that he has confidence in the Arkansas certification program and thinks that it is a good program. He indicated that Wisconsin has imported a lot of baitfish from Arkansas over the last 20 years and he has seen no disease issues related to it. He also pointed out there is a difference between infection and disease. He suggests that there are few disease issues in the wild that cause population level impacts over time. He also stated that 10 years after the outbreak of VHS virus in Lake Winnebago, they cannot detect the virus or antibodies to the virus in any fish in that system (Dr. Myron Kebus, personal communication, 12/19/17).

Gary Whelan (Program Manager Michigan DNR Fisheries) expressed greater concern over the impacts new pathogens may have in wild populations. He was especially concerned over Asian tapeworm, golden shiner virus and fathead minnow nidovirus. Overall he indicated that the Arkansas certification program is a good program and a model for others to follow. He did raise concerns over the sample size used for pathogen testing. He felt that given the large size of several of the Arkansas baitfish farms, that sample sizes may not be adequate. He also was concerned about illegal activities. He described an incidence that occurred in 2012 where an Arkansas man delivering legal baitfish and other fish into Michigan was caught selling illegal grass carp (www.mlive.com/news/index.ssf/2012/06/asian_carp.html). Whelan indicated that enforcement is important but is difficult and expensive. He did observe that once it was clear that enforcement was looking at imported baitfish, bait got cleaner, meaning there were less non-target species mixed in with the bait. He stated that if he had it to do over again, he would not allow importation of bait. Michigan is likely to impose new fish health testing requirements on fish coming into Michigan from west of the Mississippi River. In addition to the current requirement that fish be tested for VHS and *Heterosporis*, they will likely require testing for golden shiner virus and fathead minnow nidovirus (Gary Whelan, personal communication, 12/21/17).

Dave Robinson (Robinson Wholesale Bait LLC) said that Arkansas has set the bar for a certification program and that it is highly respected in many states. He told me that he buys fish from Arkansas, Minnesota, and South Dakota and that he has his own fish health plan. He typically buys fish that have been graded, but most of the time he grades them again at his facility. This provides another opportunity to "clean" the bait of non-target species. (Dave Robinson, personal communication 12/4/17). He went on to say the following, "In my opinion, the level of risk to Minnesota's wild fish stocks is extremely low if proper standards are set forth. The benefit to Minnesota dealers, distributors and anglers certainly outweighs the cost of not having any product to sell or use. It may also ease the burden on white sucker production in Minnesota which has been unable to keep up with demand for many years (Dave Robinson, personal communication, 12/05/17). He was asked if he ever sees crayfish or non-target fish in the fish he loads from Arkansas. This is his response, "To answer your question, yes. The attached document is how we deal with that. Unintended species are a way of life in fish production and there is no way around it in current methods of production. I think the focus has to be on injurious species and how they are handled and how often they are present. Like I mentioned before, zero risk is unattainable" (Dave Robinson, personal communication, 12/15/17). The document referenced in his response is a form that his truck driver must fill out when he loads fish onto the truck. It records source

of fish, water source, water temperature, condition of fish, and presence of non-target species (Appendix D). He also provided a Wisconsin (Appendix E) and an Arkansas (Appendix F) fish health report for the fish he distributes.

According to Adam Miller and Tom Jones (Vermont Agency of Natural Resources) the state of Vermont is conducting a comprehensive review of their baitfish regulations (personal communication, 1/8/18). The following are their comments regarding importation of bait into Vermont and the Arkansas baitfish certification program. The only baitfish allowed to be imported into Vermont are from Arkansas. They ended the importation of baitfish from Minnesota because of contamination by other fish species. They believe the certification program in Arkansas is functioning well but they only allow baitfish from three farms in Arkansas and there is only one importer of baitfish into Vermont. Vermont requires three consecutive years of disease free certification for VHS, IHN, IPN, SVC, furunculosis, enteric redmouth disease, *Heterosporis*, and Asian tapeworm. They have found crayfish and tadpoles in shipments of fatheads and golden shiners, but that is not a concern to them. They are also not concerned about golden shiner virus (GSV) and have not seen any problems in wild fish in Vermont related to GSV. Their biggest concern centers around the issue of chain of custody. Third party truckers are hauling baitfish to Vermont. On the way from Arkansas they could be contaminating the bait by picking up other loads of baitfish and delivering them along the way. It is in the best interest of the baitfish industry in Arkansas to help address this problem so Miller and Jones plan to bring truckers and fish farmers together to work out a solution. The Vermont Fish and Wildlife Department/Vermont Agency of Natural Resources developed a decision matrix for selecting which baitfish importation applications to approve or deny (APPENDIX G).

Future Steps, Studies, and Analyses Needed to Help Decision Making

In addition to the research needs described (above) for each of the high risk species, there are several other future steps, studies, and analyses that are needed to help make the best informed decision regarding importation of golden shiners into Minnesota.

Economic considerations

Determine economic impact of golden shiner importation

> To better understand the benefits versus the risks for importing golden shiners into Minnesota from Arkansas, an economic analysis should be conducted. The analysis should estimate the market demand and what the impact would be in terms of jobs and the economy.

Determine costs to law enforcement

> Representatives from the states of Michigan, Vermont, and Minnesota mentioned the costs of enforcing baitfish importation regulations. These costs should be closely examined and included in the economic analysis.

Legal considerations

Commerce Clause

There may be questions about what the legal implications are of allowing golden shiner importation. For example, would it open doors for other fish importation? The Maine vs Taylor Supreme Court case looked at the commerce clause and found that a Maine law prohibiting the importation of out-of-state bait was constitutional. However, if Minnesota allows the importation of one species of fish from a certified program, could it legally prohibit other species from the same or similar certified program without violating the commerce clause? In other words, if Minnesota allows golden shiners from Arkansas to be imported into the state, could the state legally ban fathead minnows from the same Arkansas certification program or ban golden shiners from another state with a certification program comparable to the one in Arkansas? The Minnesota Sea Grant Program has requested that the National Sea Grant Law Center address this question. The Sea Grant Law Center previously assisted with a similar request regarding the ban on baitfish importation into Minnesota (http://nsglc.olemiss.edu/Advisory/Gunderson.pdf). It is important to understand these legal implications, but at this time, it is unlikely that anyone would want to import fathead minnows into Minnesota from Arkansas, because Minnesota fathead minnows are much cheaper. Also, currently there are no other states that have a certification program comparable to the one in Arkansas.

Chain of Custody

Adam Miller and Tom Jones from the Vermont Agency of Natural Resources (personal communication, 1/8/18) indicated that their greatest concern was with the chain of custody of baitfish once they are loaded onto a truck at a certified farm until it arrives at the baitfish importation facility in Vermont. They worry that other non-certified baitfish could be loaded onto the truck and contaminate the baitfish that are part of the Arkansas certification program. Currently, there is no way of knowing if the baitfish have been contaminated or not. There needs to be a way to seal the tanks or develop some other system to ensure that the baitfish from the farm arrives at the destination state without the risk of cross contamination or of being replaced with uncertified baitfish.

Minnesota Enforcement Concerns

Several concerns have been expressed by MN DNR enforcement officials related to the importation of golden shiners into Minnesota from Arkansas. There is a concern that even if the golden shiners come from a certified farm, it is difficult to determine if the fish on a truck entering the state have been contaminated, are actually from the certified farm, or if fish from an uncertified facility were added to the truck (Maj. Jacqueline Glaser and Maj. Todd Kanieski, personal communication, 1/9/18). They were also concerned that baitfish hauling trucks often have manifests that aren't at standards that convey they are reliable, credible or accurate. They indicated that it is nearly impossible for an inspecting conservation officer to detect invasive fish, plants, invertebrates, or pathogens in a load of golden shiners. It is also difficult to estimate the volume of minnows on a truck to ensure that it matches the manifest. They stated that the tags they currently use are not load seals. MN DNR tags are a piece of plastic with a number that

is supposed to be affixed to the load and cross referenced on the permit. This is much different than load seals used by the trucking industry to prevent any tampering with the product in any way during transport. Majs. Glaser and Kanieski also had concerns about the additional burden this could place on their staff for issuing permits and conducting inspections.

Truck and Load Tracking

Sealing truck compartments and using GPS tracking devises is an option to help enforce chain of custody concerns. One complicating factor is that truck drivers need to inspect their loads and at times add ice during their haul (Dave Robinson, personal communication, 1/15/18). Electronic logging devices or GPS tracking could be possible. Robinson's truck drivers carry a load layout, a load manifest and an invoice from the farm. Robinson said that one farm he deals with in Arkansas provides a computer generated invoice while another provides a hand written invoice. An example of the load manifest and load layout is in APPENDIX I and J. One recommendation would be that the paperwork on the truck should be standardized so that the contents of each compartment is documented, including species and volume, where the contents came from, where they are going and appropriate fish health certificates are made available.

Develop Golden Shiner Culture Strategies for Minnesota

Advancing Golden Shiner Culture in Minnesota

The growing season in Minnesota is not long enough to grow golden shiners outdoors to market size in one growing season. An alternative may be to grow golden shiners indoors in Minnesota. Efforts to grow them indoors have been attempted but Stone et al. (2016) suggests that golden shiner fry do not adapt well to indoor culture. Growth and survival of fry grown indoors is much lower than fry stocked into ponds and golden shiners exhibit relatively slow growth in the absence of natural foods, even when fed a complete diet. He concludes that this may limit their potential for culture in indoor recirculating systems.

Part of the problem for outdoor culture of golden shiners is that in Minnesota they do not start spawning naturally until mid-June and later. If fry were available earlier for stocking into ponds, the golden shiners could have an additional six weeks or more of growing season. It would depend if there was appropriate food available in ponds, but suckers are frequently stocked into ponds in the first part of May and do well. Indoor spawning of golden shiners out of their normal spawning season is relatively easily accomplished (Kent 2009; Stone et al. 1998; Rowan and Stone 1996). Efforts should be made to examine whether enough golden shiner fry can be produced indoors and out-of-season to facilitate early stocking into ponds. Research will be needed to determine how early fry can be stocked into ponds in Minnesota and have enough food resources available for fry survival and growth, and whether the additional growing season will produce fish of market size in one season. Rather than focusing on indoor production of golden shiner fry out-of-season without knowing whether that would result in market size fish in one season, fry could be brought into Minnesota from Arkansas. Spawning naturally occurs there earlier than in Minnesota and by bringing newly hatched fry into Minnesota for stocking, the risk for many pathogens (like Asian tapeworm) and invasive species (like crayfish) would be eliminated. Minnesota has a history of helping develop baitfish culture (Dobie 1948; Dobie

1942). The Minnesota DNR could assist with the research to determine if early season stocking of golden shiners is feasible by spawning golden shiners out-of-season indoors and stocking them into ponds they have access to or by providing fry to private growers.

Many more ponds could be used for golden shiner production in Minnesota if unwanted species like bullheads, sticklebacks and mudminnows could be removed from the ponds in a cost effective manner. Carbon dioxide or ammonia injection under the ice might offer some promise (www.ncrac.org/files/project/files/Winter%20Kill%20Report.pdf). More research should be directed at refining the use of these piscicides and moving them toward application.

Additional Research Needs

Fish Pathogen Survey

It is clear that we do not know the distribution of some important fish pathogens in wild fish populations in Minnesota. We also do not know whether these pathogens are causing disease or population level impacts in wild fish. One emerging pathogen of concern is the fathead minnow nidovirus. Research by McCann (2012) and Baird (2015) suggest this virus may be a concern to several baitfish species and to muskellunge. McCann's examination of baitfish may suggest that fathead minnow nidovirus is more widespread in Minnesota than previously thought. One research priority should be to assess the incidence of this pathogen in Minnesota wild fish populations. Another pathogen of concern is the ovarian parasite of golden shiners (*Ovipleistophora ovariae*). This parasite can render female golden shiners sterile. Golden shiner samples taken from 34 bait shops in Minnesota showed an infection rate of 56% (Dr. Nicholas Phelps, personal communication, 12/4/17). If this parasite is widespread in Minnesota, this may be another reason that production of golden shiners in Minnesota ponds/lakes has declined. The fact that golden shiners generally don't mature until age two in Minnesota (Dobie et al. 1956) could exacerbate any potential impacts from the parasite. The Asian tapeworm is another emerging parasite in the region (Muzall et al. 2016). Its presence and distribution in the state should be explored.

Pathway Risk Analysis

The overall risk of baitfish importation should be evaluated in a more in depth way to look at other species of baitfish and other undesirable hitchhikers. Other things to look at should include unknown viruses as found by McCann (2012), amphibian chytrid fungus, (*Batrachochytrium dendrobatidis*), Giant Lyngbya (*Lyngbya wollei*), and Red Euglena (plants suggested by Tim Plude, personal communication, 1/22/18). The most common tadpoles found in shipments of golden shiners are the American bullfrog (*Lithobates catesbianus*) (Mark Stoll, personal communication, 2/8/18). More research should be done to look at the amphibians found in golden shiner shipments from Arkansas.

References

Anderson, Dennis. February 24, 2008. Shiner Situation. Star Tribune. Minneapolis, MN.

AR ANS MP. 2013. Arkansas Aquatic Nuisance Species Management Plan. Arkansas Game and Fish Commission. Available at: www.anstaskforce.gov/State%20Plans/Final_Arkansas_ANS_Mgmt_Plan_July_2013.pdf.

Baird, A.M. 2015 Risks of the emerging coronavirus, fathead minnow nidovirus (order: nidovirales), on representative Great Lakes fish species. A Thesis Submitted to Michigan State University. Available at: https://pdfs.semanticscholar.org/557d/f0ed68c8f2a4324eeeafd3a37b0a80c64916.pdf.

Batts, W.N., Goodwin, A.E., Winton, J.R. 2012. Genetic analysis of a novel nidovirus from fathead minnows. Journal of General Virology 93:1247-1252.

Traimat Boonthai, T., G. E. Whelan, S. J. Herbst, T. P. Loch, Q. Zhang, M. G. Van Deuren, and M. Faisal. In review. Retail baitfish harbor invasive viral pathogens including Viral Hemorrhagic Septicemia Virus, the Golden Shiner Reovirus C and the Fathead Minnow Nidovirus.

Burkhead, N.M. and J.D. Williams 1991. An Intergeneric hybrid of a native minnow, the golden shiner, and an exotic minnow, the rudd. Trans Am Fish Soc. 120:781-795.

Casselman, J.M. 2011. Changes in growth rate of Muskellunge (*Esox masquinongy*) in the upper

St. Lawrence River: Viral hemorrhagic septicemia and growth-rate selective mortality. Queen's University, Kingston, Ontario. Manuscript report, 13 pages

Casey, J. 2009. New Zealand Mudsnails. Available at: http://depts.washington.edu/oldenlab/wordpress/wp-content/uploads/2013/03/Potamopyrgus-antipodarum_Casey.pdf.

CDC Fact Sheet. 2017. Estimated range of Aedes aegypti and *Aedes albopictus* in the United States. Available at: www.cdc.gov/zika/vector/range.html.

CDC Fact Sheet 2017. Surveillance and Control of Aedes aegypti and *Aedes albopictus* in the United States. Available at: www.cdc.gov/chikungunya/pdfs/Surveillance-and-Control-of-Aedes-aegypti-and-Aedes-albopictus-US.pdf.

Circular 21. 2010. Regulations on Aquaculture in Arkansas. Available at: www.ncrac.org/files/page/files/circular21Aquaculture.pdf/.

Davis, C. Feb. 25, 2016. Invasive black carp weren't supposed to be capable of reproducing, but they are. Missouri Department of Conservation. Available at: https://mdc.mo.gov/newsroom/mdc-invasive-black-carp-weren-t-supposed-be-capable-reproducing-they-are.

Dixon P, Paley R, Alegria-Moran R, Oidtmann B. 2016. Epidemiological characteristics of infectious hematopoietic necrosis virus (IHNV): a review. Vet Res.; 47:63. Available at: www.ncbi.nlm.nih.gov/pmc/articles/PMC4902920/.

Dobie, J. 1948. Minnow propagation. Bulletin No. 13, Minnesota Department of Conservation, St. Paul.

Dobie, J. 1972. Rearing suckers for bait in Minnesota. Investigational Report No. 256, Minnesota Department of Natural Resources Division of Game and Fish Section of Fisheries, St. Paul.

Dobie, J.R., O.L. Meehan, S.F. Snieszko, and G.N. Washburn. 1956. Raising baitfishes. U.S. Fish Wildl. Serv. Circ. 35. 123 pp.

Fetzner Jr., J. 2011. State of Arkansas – Crayfish Species Checklist. Available at: http://iz.carnegiemnh.org/crayfish/country_pages/state_pages/arkansas.htm.

Haller, W.T. Chapter 15.1: Hydrilla. Available at: www.aquatics.org/bmpchapters/Chapter_15-01.pdf.

Hawke, J.P. 2015. Enteric Septicemia of Catfish. SRAC Publication No. 477. 6 pp. Available at: https://srac.tamu.edu/serveFactSheet/124.

Helgen, J.C. 1990. The distribution of crayfish in Minnesota. Section of Fisheries Investigational Report Number 405. Minnesota Department of Natural Resources. 106 pp. Available at: http://files.dnr.state.mn.us/publications/fisheries/investigational_reports/405.pdf.

Iowa State University Center for Food Security and Public Health 2007a. "Infectious Hematopoietic Necrosis" Center for Food Security and Public Health Technical Factsheets. 54. Available at: http://www.cfsph.iastate.edu/Factsheets/pdfs/infectious_hematopoietic_necrosis.pdf.

Iowa State University Center for Food Security and Public Health. 2007b. "Spring Viremia of Carp" Center for Food Security and Public Health Technical Factsheets. Available at: http://www.cfsph.iastate.edu/Factsheets/pdfs/spring_viremia_of_carp.pdf.

Kent, Thomas. (2009) "New investigations into golden shiner culture" Graduate Theses and Dissertations. 12251. Available at: http://lib.dr.iastate.edu/etd/12251.

Kokotovich, A., Andow, D., Aadland, L., Bertrand, K., Coulter, A., Frohnauer, N., Hoff, M., Hoxmeier, J., O'Hara, M., Phelps, Q., Reeves, K., Rutherford, E., and Iber,M. 2017. Minnesota Bigheaded Carps Risk Assessment - A report for the Minnesota Department of Natural Resources. University of Minnesota – Minnesota Invasive Species Research Center. 138 pp.

Kuner, G., K. Menanteau-Ledouble, M. Saleh and M. El-Matbouli. 2015. *Yersinia ruckeri*, the causative agent of enteric redmouth disease in fish. Veterinary Research 46:103. 10 pp. Available at: https://veterinaryresearch.biomedcentral.com/articles/10.1186/s13567-015-0238-4.

McCann, R. 2012. Viral survey of fathead minnows, golden shiners, and white suckers from baitfish dealers in Wisconsin. Thesis. MS in Biology, May 2012, 65 pp. Available at: https://minds.wisconsin.edu/handle/1793/62269.

Muzall,P.M, M.V. Thomas, G. WHELAN. 2016. Occurrence of the Asian Fish Tapeworm, *Bothriocephalus acheilognathi*, in *Notropis* spp. (Cyprinidae) in Saginaw Bay and Port Sanilac, Lake Huron, and Lake St. Clair, Michigan, U.S.A. Comp. Parasitol.83(1), pp. 124–129

MPR, August 4 2016. MN officials hunt for possible Zika-carrying mosquitoes. Available at: www.mprnews.org/story/2016/08/04/health-officials-search-minnesota-for-zika-carrying-mosquito.

National Control and Management Plan for Members of the Snakehead Family Channidae, 2014. Available at: www.fwspubs.org/doi/suppl/10.3996/102014-JFWM-075/suppl_file/102014-jfwm-075.s5.pdf.

National Invasive Species Act 1996 (PL 104-332). Available at: www.anstaskforce.gov/Documents/NISA1996.pdf.

Nehring RB, Walker PG. 1996. Whirling disease in the wild: The new reality in the intermountain west. Fisheries, 21:28–30.

Nico, L.G., J.D. Williams, and H.L. Jelks. 2005. Black Carp: Biological Synopsis and Risk Assessment of an Introduced Fish, American Fisheries Society Special Publication 32, Bethesda, MD. 337 pp.

Nico, L., and P. Fuller. 2005. Gambusia affinis. Nonindigenous Aquatic Species Database, Gainesville, Florida. Accessed December 2017. Available at: https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=846.

Phelps, N. B. D., A. Armien, S. K. Mor, S. M. Goyal, J. V. Warg, R. Bhagyam, T. Monahan. 2012. Spring viremia of carp virus in the Minnehaha Creek, Minnesota. Journal of Aquatic Animal Health 24:232-237.

Richards, C., J.L. Gunderson, P. Tucker, and M. McDonald. 1995. Crayfish and baitfish culture in wild rice paddies. Tech Rep No. NRRI/TR-95/39. 35 pp.

Risk Assessment and Management Committee. 1996. Report to the Aquatic Nuisance Species Task Force: Generic Nonindigenous Aquatic Organisms Risk Analysis Review Process. October 21, 1996.

Rowan, M., and N. Stone. 1996. Off-season spawning of golden shiners. The Progressive Fish Culturist 58:62-64.

Ruane, N., F. Geoghegan, and Ml Ó Cinneid. (2007). Infectious pancreatic necrosis virus and its impact on the Irish salmon aquaculture and wild fish sectors. Marine Environment & Health Series, No. 30. 48 pp. Available at: https://oar.marine.ie/bitstream/handle/10793/270/No%2030%20Marine%20Environment%20and%20Health%20Series.pdf.

Scholz T, Kuchta R, Williams C. *Bothriocephalus acheilognathi*. In: Woo PTK, Buchmann K, editors. Fish parasites: pathobiology and protection. Wallingford: CAB International; 2012. p. 282-97.

Spring Viremia of Carp. 2007. Available at: www.cfsph.iastate.edu/Factsheets/pdfs/spring_viremia_of_carp.pdf.

Steinbach Elwell, L.C., K.E. Stromberg, E. K.N. Ryce, and J. L. Bartholomew. 2009. Whirling Disease in the United States: A Summary of Progress in Research and Management. Available at: http://fwp.mt.gov/fwpDoc.html?id=40473.

Stone, N. M., A. M. Kelly, and L.A. Roy. 2016. A Fish of Weedy Waters: Golden Shiner Biology and Culture. J. World Aquaculture Society. Vol. 47, No. 2. pp 152-199.

Stone, N. M., C.R. Engle, and E. Park. 2008. Production Enterprise Budget for Golden Shiners. SRAC Publication No. 122. 8 pp. Available at: https://articles.extension.org/mediawiki/files/a/a2/Enterprise_Budget_for_Goldent_Shiners.pdf.

Stone, N.M., E. McNulty, and E. Park. 1998. Tank spawning and hatching of golden shiners. Cooperative Extension Service Bulletin FSA9081-1M-12-98N. University of Arkansas, Pine Bluff.

Summerfelt R. C. and Goodwin A. E. (2010). Ovipleistophoriasis: a microsporidian disease of the golden shiner ovary. In American Fisheries Society-Fish Health Section Blue Book: Suggested Procedures for the

Summerfelt, R.C., and M.C. Warner. 1970a. Incidence and intensity of infection of Pleistophora ovariae, a microsporidian parasite of the golden shiner, Notemigonus crysoleucas. in S.F. Snieszko, ed. A s

Summerfelt, R.C., and M.C. Warner. 1970b. Geographic distribution and host-parasite relationships of *Pleistophora ovariae* (Microsporida, Nosemantidae) in *Notemigonus crysoleucas*. Journal of Wildlife Diseases 6:457-465. Symposium on diseases of fishes and shellfishes. Special Publication No. 5, American Fisheries Society, Washington, D.C

Detection and Identification of Certain Finfish and Shellfish Pathogens, 1.3.2.3, 2016 edition. Available at: http://afs-fhs.org/bluebook/bluebook-index.php.

USFWS National Wild Fish Health Survey. Available at: www.fws.gov/wildfishsurvey/ (Accessed December 2017).

USFWS. 2015a. Red Swamp Crayfish (*Procambarus clarkii)* Ecological Risk Screening Summary. Available at: www.fws.gov/fisheries/ans/erss/highrisk/Procambarus-clarkii-ERSS-revision-May2015.pdf.

USFWS 2015b. White River Crayfish (*Procambarus acutus*) Ecological Risk Screening Summary. Available at: www.fws.gov/fisheries/ans/erss/uncertainrisk/Procambarus-acutus-ERSS-July2015.pdf.

USFWS 2017. Northern Snakehead (*Channa argus*) Ecological Risk Screening Summary. Available at: www.fws.gov/fisheries/ans/erss/highrisk/Channa-argus-ERSS-FINAL-Sept-2017.pdf.

USFWS 2017b. Western mosquitofish (*Gambusia affinis*) Ecological Risk Screening Summary. Available at: www.fws.gov/fisheries/ans/erss/highrisk/Gambusia-affinis-ERSS-FINAL.pdf.

USDA. 2013. Census of Aquaculture. United States Department of Agriculture Census of Agriculture. Available at: www.agcensus.usda.gov/Publications/2012/Online_Resources/Aquaculture/.

U.S. Geological Survey. [2017]. Nonindigenous Aquatic Species Database. Gainesville, Florida. Accessed [12/2017].

Warren, J.W. Enteric redmouth disease. U.S. Department of the Interior FWS. La Crosse, WI. Available at: www.glfc.org/pubs/SpecialPubs/sp83_2/pdf/chap24.pdf.

Whiteman, J.B. and P.M. Room. 1991. Temperatures lethal to *Salvinia molesta* Mitchell. Aquatic Botany 40:27-35

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Appendices

Appendix A

Table: Species of Concern Risk Analysis

Risk Assessment Questions	**Certified by AR**	**Distribution in AR**	**Distribution in MN**	**Likelihood of transfer**	**Likelihood of establishment**	**Impact if established**	**Likelihood of other pathways**
Risk Assessment Potential Responses	**Yes/ No**	**Common/ Fairly Common/ Uncommon/ Stray/ Not Detected/ Unknown**	**Common/ Fairly Common/ Uncommon/ Stray/ Not Detected/ Unknown**	**High/ Medium/ Low**	**High/ Medium/ Low**	**Severe/ Moderate/ Low/ Unknown**	**High/ Moderate/ Low/ Unknown**
Viral Hemorrhagic Septicemia (VHS)	Yes	Not Detected	Uncommon	Low	High	Severe	Moderate
Infectious Hematopoietic Necrosis (IHN)	Yes	Not Detected	Not Detected	Low	High	Moderate	Low
Infectious Pancreatic Necrosis (IPN)	Yes	Uncommon	Stray	Low	High	Low	Low
Fathead Minnow Nidovirus (FHMNV)	Yes (if requested)	Not Detected	Unknown	Low	High	Moderate	Moderate
Spring Viremia of Carp (SVC)	Yes	Not Detected	Uncommon	Low	High	Low	Moderate
Heterosporis (*Heterosporis sutherlandae)*	Yes (if requested)	Not Detected	Uncommon	Low	High	Low	High
Golden Shiner Virus (GSV)	Yes (if requested)	Common	Unknown	Medium	High	Moderate	Moderate

Risk Assessment Questions	**Certified by AR**	**Distribution in AR**	**Distribution in MN**	**Likelihood of transfer**	**Likelihood of establishment**	**Impact if established**	**Likelihood of other pathways**
Asian Tapeworm (*Schyzocotyle acheilognathi*)	Yes (if requested)	Fairly Common	Unknown	Medium	High	Moderate	Moderate
Koi Herpes Virus (KHV)	Yes (if requested)	Uncommon	Uncommon	Low	High	Low	Moderate
Whirling Disease (*Myxobolus cerebralis*)	No	Not Detected	Not Detected	Low	Medium	Severe	Low
Edwardsiella tarda	Yes (if requested)	Uncommon	Uncommon	Low	High	Low	Moderate
Largemouth Bass Virus (LMBV)	Yes (if requested)	Common	Uncommon	Low	High	Low	Moderate
Channel Catfish Virus	No	Uncommon	Not Detected	Low	Low	Low	Low
Enteric Septicemia of Catfish (ESC)	No	Common	Not Detected	Low	Low	Low	Low
Ovarian Parasite (Ovipleistophora ovariae)	No	Common	Stray	High	High	Severe	High
Furunculosis (Aeromones salmonicida)	Yes	Uncommon	Common	Low	High	Moderate	Low
Enteric Redmouth Disease (Yersinia ruckeri)	Yes	Uncommon	Uncommon	Low	High	Low	Low
Bighead Carp (*Hypophthalmichthys nobilis*)	Yes	Fairly Common	Uncommon	Low	Medium	Moderate	Moderate

Risk Assessment Questions	**Certified by AR**	**Distribution in AR**	**Distribution in MN**	**Likelihood of transfer**	**Likelihood of establishment**	**Impact if established**	**Likelihood of other pathways**
Black Carp (*Mylopharyngodon piceus*)	No	Uncommon	Not Detected	Low	Medium	Moderate	Moderate
Grass Carp (*Ctenopharyngodon idella*)	No	Common	Uncommon	Low	Medium	Moderate	High
Silver Carp (*Hypophthalmichthys molitrix*)	Yes	Fairly Common	Uncommon	Low	Medium	Moderate	Moderate
Northern Snakehead (*Channa argus*)	Yes	Uncommon	Not Detected	Low	High	Severe	Low
Western Mosquitofish (*Gambusia affinis*)	No	Common	Stray	Medium	Medium	Moderate	Low
White Perch (*Morone americana*)	No	Uncommon	Uncommon	Low	High	Severe	Moderate
European Rudd (*Scardinius erythrophthalmus*)	Yes	Stray	Not Detected	Low	High	Unknown	Low
Goldfish (*Carassius auratus*)	No	Common	Uncommon	Medium	Medium	Low	High
Asian Tiger Mosquito (*Aedes albopictus*)	No	Fairly Common	Stray	Low	Low	Unknown	High
Non-native Crayfish (*Procambarus clarkii and P. acutus*)	No	Common	Stray	High	High	Moderate	Moderate

Risk Assessment Questions	**Certified by AR**	**Distribution in AR**	**Distribution in MN**	**Likelihood of transfer**	**Likelihood of establishment**	**Impact if established**	**Likelihood of other pathways**
Zebra and Quagga Mussels (*D. polymorpha* and *D. rostriformis bugensis*)	Yes	Fairly Common	Fairly Common	Low	High	Severe	High
New Zealand Mudsnail (*Potamopyrgus antipodarum*)	Yes	Not Detected	Stray	Low	High	Severe	High
Eurasian Watermilfoil (EWM, *Myriophyllum spicatum*)	Yes	Uncommon	Common	Low	High	Severe	High
Hydrilla (*Hydrilla verticillata*)	Yes	Uncommon	Not Detected	Low	Medium	Severe	High
Giant Salvinia (*Salvinia molesta*)	Yes	Stray	Not Detected	Low	Low	Severe	High

APPENDIX B

Laboratories Approved to Conduct Diagnostic Testing in Support of Export
September 20, 2017

Health Certification of Aquaculture Species
University of Arkansas Pine Bluff -Lonoke
Fish Health Inspection Laboratory
Lonoke Agricultural Center
Lonoke, AR 72086
Phone: (501) 676-3124
Last inspection date: December 10, 2015

Disease	Testing Method
Epizootic ulcerative syndrome	PCR
Infectious hematopoietic necrosis	Virus isolation
Koi herpesvirus disease	RT-PCR for virus identification (sequence)
Red sea bream iridoviral disease	Virus isolation
	PCR for virus identification (sequence)
Spring viremia of carp	Virus isolation
	RT-PCR for virus identification (sequence)
Viral hemorrhagic septicemia Virus	Virus isolation
	RT-PCR for virus identification (sequence)

APPENDIX C

Fish Inspection Report

(Michigan)

University of Arkansas at Pine Bluff
Fish Health Inspection Laboratory at Lonoke
December 4, 2017

Sample source: [redacted]

Sample Description: A farm-level sample consisting of 60 fathead minnows (*Pimephales promelas*), 60 golden shiners (*Notemigonus crysoleucas*), 60 goldfish (*Carassius auratus)* and 150 channel catfish (*Ictalurus punctatus*) was collected from across the farm under the supervision of an APHIS Certified Veterinarian (Dr. Marilynn Baeyens, 8620 Hwy 107, Sherwood, AR 72120, 501-993-2065). Fish were submitted live to the laboratory on November 7, 2017. **Case ID #LN17-129.**

Inspection Performed: Spleen and trunk kidney tissue samples from all fish of each species were inoculated on FHM, BF-2, and CCO (catfish only) cell lines, including a blind passage, and examined for fish viruses including SVCV, VHSV, IPNV, and IHNV according to inspection protocols based on OIE, APHIS, and/or FHS-AFS Bluebook Standards and/or Northeast Fish Health Committee Guidelines. Trunk kidneys were cultured on BHI agar for bacteria. All fish were observed for signs of *Heterosporis* spp. Sixty golden shiners and 60 fathead minnows were also inspected for the presence of Asian tapeworm (*Bothriocephalus acheilognathi*) in the intestines.

Results: All of the fish were negative for SVCV, IHNV, VHSV, and IPNV. No cytopathic effects were observed in any cell line. No primary bacterial pathogens were isolated. No signs of *Heterosporis* spp. were observed and no Asian tapeworms were found.

Additional Notes: [redacted] has been regularly inspected for viruses since 2006. No pathogens reportable to the OIE have ever been detected in any regulatory or clinical sample submitted by this farm. The farm is certified free of important ANS species (including zebra, quagga, and Conrad's false mussels, and New Zealand mud snails) by the Arkansas Agriculture Department.

Inspected by:

Associate Director/Extension Fish Health Specialist
AFS/FHS Fish Health Inspector
UAPB, Fish Health Inspection Laboratory at Lonoke
Phone: 501-676-3124; Email: kellya@uapb.edu

APPENDIX D

ROBINSON WHOLESALE BAIT LLC.

603 Freeman Street
Genoa City, WI 53128
Phone: 262-279-6888 • Fax: 262-279-2331
E-mail: *bait@robinsonwholesaleinc.com*

Driver Report
RE: HAACP Plan

Date: _____
Driver: _____

Source of Fish: ___ Dakota; ___ Urbank; ___Pillow; ___Coldstream;
***Other Source(s):** _____

Hauling water source: ___ Well; ***Other (please describe)**

Water temperature: Source ____ Loading ____ Departure ____ Target: **52**
***Actual Water Temperature Upon Arrival:* _____**

Condition of fish prior to loading:
Acceptable _____ Questionable _____ ***Unacceptable** _____
REFUSE SHIPMENT IF ASIAN CARP ARE OBSERVED IN TANKS
Presence of unintended species noted: ****Gambusia**_____ Goldfish _____
Sticklebacks (Brook or nine spine) ____ Bigmouth Buffalo _____
Frog Larvae _____ Waterdogs _____Green sunfish _____
Other: _____

***Presence of injurious species:**
Carp _____ White Perch _____ Rudd _____
Sticklebacks (Three spine or Four Spine) _____ Ruffe_____
Other _____

***Checkmarks or notes in these items require home office approval before loading or departure from load site.**

- **Office: 262-279-6888 David Robinson: H 262-877-4382; C 262-649-6579**
- **Jerry Boyd: C 262-215-7416 Mike Robinson: C 262-649-6580**

****

WISCONSIN PROHIBITED SPECIES: Identify any compartments contaminated with Gambusia, notify supplier, but allow transport. Fax load layout to office with contaminated compartments identified as such. *Plan updated November, 2011.*

AH-AQ-2803 (rev. 02/2010) PREVIOUS VERSIONS SHOULD BE DESTROYED

APPENDIX E

SUBMIT ORIGINAL WITHIN SEVEN DAYS AFTER ISSUE TO:
Wisconsin Department of Agriculture,
Trade and Consumer Protection
Division of Animal Health
PO Box 8911, Madison, WI 53708-8911
Phone: 608-224-4872 Fax: 608-224-4871

OFFICE USE ONLY

FISH HEALTH CERTIFICATE

ATCP 10.65, Wis. Adm. Code

FISH SOURCE INFORMATION

See Page 2 for required certificate contents based on movement and fish type.

INSPECTION DATE 06/26/2017	ISSUE DATE 07/15/2017 (A fish health certificate CANNOT be issued until test results are obtained.)
FISH FARM REGISTRATION 265083-AQ	LIVESTOCK PREMISES CODE (if any) 007BEGH
FISH FARM NAME Robinson Wholesale Bait, LLC	OWNER / MANAGER NAME David Robinson
FISH FARM ADDRESS / CITY / STATE / ZIP 603 Freeman St. Genoa City, WI 53128	BUSINESS ADDRESS / CITY / STATE / ZIP Same
TYPE OF WATER SUPPLY (Check all that apply) ☐ Lake ☐ Stream ☐ Spring ☒ Well ☐ Other (specify) _____	TYPE OF FISH HEALTH CERTIFICATE (FHC) ☒ Annual (Expires 12 months from date issued) ☐ Lot (Expires 30 days from date issued)

List fish species present on date of inspection. FHM, GOS, WSK, GOF

QUALIFIED FISH HEALTH INSPECTOR INFORMATION (4)

PRINTED NAME David M Vandever, D.V.M.		CONTACT TELEPHONE 414-529-9815
LICENSE NUMBER 2315	ADDRESS 12381 W. Saint Martins Rd.	CITY / STATE /ZIP Franklin, WI 53132

I certify that fish for any required laboratory tests have been sampled and inspected by lot or facility according to the current version of the Inspection Section of the AFS-FHS Blue Book or the OIE Manual and Code. I have also visually inspected a minimum of 60 fish per species (or 100% of the population for populations of 60 fish or less) and certify that the fish have no gross clinical signs of contagious or infectious diseases except as noted on this form. All laboratory test results are summarized in the table below and the laboratory's report is appended to this document.

SIGNATURE OF QUALIFIED FISH HEALTH INSPECTOR (4) **& DATE**

Dr. David M. Vandever 7-15-2017

Comments on visible signs of contagious or infectious disease (5).

All fish appeared vigorous and healthy. No reportable fish diseases have been found on this farm in the past 2 years. No evidence of heterosporis or contracecum sp. seen on visual exam with magnification.

LABORATORY TESTING (3)

See Page 2 for accepted test methodology. Number sampled (line 1) and results (line 2)

Species (1)	Lot Number	Age (2)	Number in Lot	Sampling Date	Farm (F) Wild (W)	Viral Hemorrhagic Septicemia	Whirling Disease	Other: IPNV	Other: IHNV	Other: FHMNV	Other: _____
FHM	M17-350	13	315000	6/26/17	F	30 NEG	_____ _____	30 NEG	30 NEG	30 NEG	_____ _____
FHM	M17-351	13	465750	6/26/17	F	40 NEG	_____ _____	40 NEG	40 NEG	40 NEG	_____ _____
FHM	M17-352	12	620000	6/26/17	F	55 NEG	_____ _____	55 NEG	55 NEG	55 NEG	_____ _____
						_____ _____	_____ _____	_____ _____	_____ _____	_____ _____	_____ _____
						_____ _____	_____ _____	_____ _____	_____ _____	_____ _____	_____ _____

Attach copies of laboratory test results required (ATCP 10.65).

Some of the information you provide on this Fish Health Certificate is CONFIDENTIAL, as provided by s. 95.60(7), Wis. Stats., and not subject to Open Records requests under s. 19.35, Wis. Stats., except as the department determines is necessary to protect fish health or prevent the spread of disease.

APPENDIX E cont.

REQUIRED CERTIFICATE CONTENTS

(1) Use STANDARD ABBREVIATIONS (see page 3).
(2) AGE: for hatchery fish give the age in months; for wild fish use one of the following:
E = eggs or fry F = fingerlings Y = yearlings B = older fish
(3) ACCEPTED TESTING METHODOLOGIES:
All laboratory testing required on the FHC must be performed using either the current USFWS/AFS-FHS Standard Procedures for Aquatic Animal Health Inspections as detailed in the Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens, American Fisheries Society, Fish Health Section, Bethesda, Maryland: **OR** The World Organization for Animal Health (OIE) Manual of diagnostic Tests for Aquatic Animals, OIE, Paris, France or a protocol approved by APHIS for export inspection.
A fish health certificate shall include test results from a qualified laboratory to confirm those test results listed on the certificate form.
A qualified laboratory is one of the following:

- A lab approved by the federal bureau for purposes of disease testing related to interstate movement of fish or fish eggs.
- A lab approved by DATCP for purposes of disease testing of fish or fish eggs.
- A federal or state veterinary diagnostic laboratory. (s. ATCP 10.67(2), Wis. Adm. Code.)

For purposes of this certificate a laboratory test result is rebuttably presumed to be valid if the department or the federal bureau has approved or certified the laboratory to perform that type of test.
(4) QUALIFIED FISH HEALTH INSPECTOR must be one of the following:

- A WI certified veterinarian who has completed a training program approved by DATCP.
- A fish health inspector or pathologist certified by the American Fisheries Society that has taken a training program approved by DATCP.
- For inspection and sampling outside of WI, any accredited veterinarian. (s. ATCP 10.67 (1) Wis. Adm. Code)

(5) COMMENTS regarding visible signs of contagious or infectious disease are included as part of the visual inspection.

Any person affected adversely by any DATCP action on this FHC may petition the Department for a hearing under s. ATCP 1.06, Wis. Adm. Code. The request shall identify the action on which a hearing is sought, the grounds for the hearing request, and the relief sought. Hearings shall be granted or denied within 20 days following the filing of a complete request with DATCP.

(3) REQUIRED TESTING

*A "wild source" includes a wild source in this state or outside this state. Fish and fish eggs imported from other states (including bait fish and fish eggs) must also comply with import requirements under s. ATCP 10.62. Species that the federal bureau has found to be susceptible to viral hemorrhagic septicemia are listed at http://www.aphis.usda.gov/vs/aqua/pdf/vhs_susceptible_species.pdf.

Fish for any required laboratory tests must be sampled and inspected by lot or facility according to the current version of the Inspection Section of the AFS-FHS Blue Book or the OIE Manual and Code. A minimum of 60 fish per species (or 100% of the population for populations of 60 fish or less) must be visually inspected for gross clinical signs of contagious or infectious diseases and any findings noted on this form.
Laboratory Tests required for importing any live fish or fish eggs into Wisconsin [ATCP 10.62(3)]:

- Infectious hematopoietic necrosis, viral hemorrhagic septicemia (VHS) and whirling disease (*Myxobolus cerebralis*) if an import shipment covered by the health certificate includes salmonids.
- White sturgeon iridovirus if an import shipment covered by the health certificate includes sturgeon.
- Viral hemorrhagic septicemia (VHS) if an import shipment covered by the health certificate includes fish or fish eggs from a state or province where that disease is known to occur.

Laboratory tests required for stocking live fish or fish eggs into waters of Wisconsin [ATCP 10.63]:

- Whirling disease (*Myxobolus cerebralis*) if a farm or shipment covered by the health certificate includes salmonids.
- Viral hemorrhagic septicemia (VHS) if a farm or shipment covered by the health certificate includes any of the following fish or fish eggs of a species that the federal bureau has found to be susceptible to viral hemorrhagic septicemia (VHS):
  - Fish or fish eggs collected from a wild source* within the 12 month period immediately preceding the shipment.
  - Fish or fish eggs kept at a fish farm that received fish or fish eggs of any species collected from a wild source within the 12 month period immediately preceding the distribution date.

Laboratory tests required for farm to farm movement of any live fish or fish eggs in Wisconsin [ATCP 10.64] (see Exception below):

- Viral hemorrhagic septicemia (VHS) if a farm or shipment covered by the health certificate includes any of the following fish or fish eggs of a species that the federal bureau has found to be susceptible to viral hemorrhagic septicemia (VHS):
  - Fish or fish eggs collected from a wild source within the 12 month period immediately preceding the shipment.
  - Fish or fish eggs kept at a fish farm that received fish or fish eggs of any species collected from a wild source within the 12 month period immediately preceding the distribution date.

EXCEPTIONS [ATCP 10.64(3)]:

- Fish or fish eggs moved between fish farms registered under s. ATCP 10.61 by the same fish farm operator, if the operator keeps a complete record of the movement under s. ATCP 10.61(10). This exemption does not apply to the movement of fish or fish eggs from a type 3 fish farm to a type 1 or type 2 fish farm, or, the movement of fish or fish eggs between fish farms that are required under s. ATCP 10.61(5m) to be medically separated.
- Fish or fish eggs moved to a food processing plant, retail food establishment or restaurant for processing or direct sale consumers, provided that the receiving entity does not hold any of the fish or fish eggs for more than 30 days prior to slaughter or direct sale to consumers, commingle the fish or fish eggs with fish or fish eggs that may be used for any other purpose, sell or distribute unprocessed fish or fish eggs to consumers at any place other than the food processing plant, retail food establishment or restaurant at which the entity first receives them, discharge to waters of the state any untreated water used to hold or process any of the fish or fish eggs, and dispose of any dead fish, dead fish eggs or fish offal except by rendering, composting, municipal solid waste disposal, or other means approved by the department.

Laboratory Tests required for wild source live fish or fish eggs distributed for use as bait [ATCP 10.645]:

- Viral hemorrhagic septicemia (VHS) if a farm or shipment covered by the health certificate includes any of the following fish or fish eggs of a species that the federal bureau has found to be susceptible to viral hemorrhagic septicemia (VHS):
  - Fish or fish eggs collected from a wild source within the 12 month period immediately preceding the shipment.
  - Fish or fish eggs kept at a fish farm that received fish or fish eggs of any species collected from a wild source within the 12 month period immediately preceding the distribution date.

A fish health certificate is not required for the movement of live fish or fish eggs between fish farms that are registered by the same registrant provided that the registrant keeps complete records of the movement.

AH-AQ-2803 (rev. 02/2010) PREVIOUS VERSIONS SHOULD BE DESTROYED

APPENDIX E cont.

SUBMIT ORIGINAL WITHIN SEVEN DAYS AFTER ISSUE TO:
Wisconsin Department of Agriculture,
Trade and Consumer Protection
Division of Animal Health
PO Box 8911, Madison, WI 53708-8911
Phone: 608-224-4872 Fax: 608-224-4871

OFFICE USE ONLY

FISH HEALTH CERTIFICATE

ATCP 10.65, Wis. Adm. Code

FISH SOURCE INFORMATION

See Page 2 for required certificate contents based on movement and fish type.

INSPECTION DATE 06/26/2017	ISSUE DATE 07/15/2017 (A fish health certificate CANNOT be issued until test results are obtained.)
FISH FARM REGISTRATION 265083-AQ	LIVESTOCK PREMISES CODE (if any) 007BEGH
FISH FARM NAME Robinson Wholesale Bait, LLC	OWNER / MANAGER NAME David Robinson
FISH FARM ADDRESS / CITY / STATE / ZIP 603 Freeman St. Genoa City, WI 53128	BUSINESS ADDRESS / CITY / STATE / ZIP Same
TYPE OF WATER SUPPLY (Check all that apply) ☐ Lake ☐ Stream ☐ Spring ☒ Well ☐ Other (specify) ____	TYPE OF FISH HEALTH CERTIFICATE (FHC) ☒ Annual (Expires 12 months from date issued) ☐ Lot (Expires 30 days from date issued)

List fish species present on date of inspection. FHM, GOS, WSK, GOF

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PRINTED NAME David M Vandever, D.V.M.		CONTACT TELEPHONE 414-529-9815
LICENSE NUMBER 2315	ADDRESS 12381 W. Saint Martins Rd.	CITY / STATE /ZIP Franklin, WI 53132

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SIGNATURE OF QUALIFIED FISH HEALTH INSPECTOR (4) & DATE

Dr. David M. Vandever 7-15-2017

Comments on visible signs of contagious or infectious disease (5).

All fish appeared vigorous and healthy. No reportable fish diseases have been found on this farm in the past 2 years. No evidence of heterosporis or contracecum sp. seen on visual exam with magnification.

LABORATORY TESTING (3)

See Page 2 for accepted test methodology. Number sampled (line 1) and results (line 2)

Species (1)	Lot Number	Age (2)	Number in Lot	Sampling Date	Farm (F) Wild (W)	Viral Hemorrhagic Septicemia	Whirling Disease	Other: IPNV	Other: IHNV	Other: FHMNV	Other: ____
GOS	M17-353	9-13	178600	6/26/17	F	15 NEG	____ ____	15 NEG	15 NEG	15 NEG	____ ____
GOF	M17-354	13	7600	6/26/17	F	5 NEG	____ ____	5 NEG	5 NEG	5 NEG	____ ____
WSK	M17-355	12	16700	6/26/17	F	5 NEG	____ ____	5 NEG	5 NEG	5 NEG	____ ____
						____ ____	____ ____	____ ____	____ ____	____ ____	____ ____
						____ ____	____ ____	____ ____	____ ____	____ ____	____ ____

Attach copies of laboratory test results required (ATCP 10.65).

Some of the information you provide on this Fish Health Certificate is CONFIDENTIAL, as provided by s. 95.60(7), Wis. Stats., and not subject to Open Records requests under s. 19.35, Wis. Stats., except as the department determines is necessary to protect fish health or prevent the spread of disease.

APPENDIX E cont.

REQUIRED CERTIFICATE CONTENTS

(1) Use STANDARD ABBREVIATIONS (see page 3).
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All laboratory testing required on the FHC must be performed using either the current USFWS/AFS-FHS Standard Procedures for Aquatic Animal Health Inspections as detailed in the Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens, American Fisheries Society, Fish Health Section, Bethesda, Maryland: **OR** The World Organization for Animal Health (OIE) Manual of diagnostic Tests for Aquatic Animals, OIE, Paris, France or a protocol approved by APHIS for export inspection.
A fish health certificate shall include test results from a qualified laboratory to confirm those test results listed on the certificate form.
A qualified laboratory is one of the following:

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- A lab approved by DATCP for purposes of disease testing of fish or fish eggs.
- A federal or state veterinary diagnostic laboratory. (s. ATCP 10.67(2), Wis. Adm. Code.)

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(4) QUALIFIED FISH HEALTH INSPECTOR must be one of the following:

- A WI certified veterinarian who has completed a training program approved by DATCP.
- A fish health inspector or pathologist certified by the American Fisheries Society that has taken a training program approved by DATCP.
- For inspection and sampling outside of WI, any accredited veterinarian. (s. ATCP 10.67 (1) Wis. Adm. Code)

(5) COMMENTS regarding visible signs of contagious or infectious disease are included as part of the visual inspection.

Any person affected adversely by any DATCP action on this FHC may petition the Department for a hearing under s. ATCP 1.06, Wis. Adm. Code. The request shall identify the action on which a hearing is sought, the grounds for the hearing request, and the relief sought. Hearings shall be granted or denied within 20 days following the filing of a complete request with DATCP.

(3) REQUIRED TESTING

*A "wild source" includes a wild source in this state or outside this state. Fish and fish eggs imported from other states (including bait fish and fish eggs) must also comply with import requirements under s. ATCP 10.62. Species that the federal bureau has found to be susceptible to viral hemorrhagic septicemia are listed at http://www.aphis.usda.gov/vs/aqua/pdf/vhs_susceptible_species.pdf.

Fish for any required laboratory tests must be sampled and inspected by lot or facility according to the current version of the Inspection Section of the AFS-FHS Blue Book or the OIE Manual and Code. A minimum of 60 fish per species (or 100% of the population for populations of 60 fish or less) must be visually inspected for gross clinical signs of contagious or infectious diseases and any findings noted on this form.
Laboratory Tests required for importing any live fish or fish eggs into Wisconsin [ATCP 10.62(3)]:

- Infectious hematopoietic necrosis, viral hemorrhagic septicemia (VHS) and whirling disease (*Myxobolus cerebralis*) if an import shipment covered by the health certificate includes salmonids.
- White sturgeon iridovirus if an import shipment covered by the health certificate includes sturgeon.
- Viral hemorrhagic septicemia (VHS) if an import shipment covered by the health certificate includes fish or fish eggs from a state or province where that disease is known to occur.

Laboratory tests required for stocking live fish or fish eggs into waters of Wisconsin [ATCP 10.63]:

- Whirling disease (*Myxobolus cerebralis*) if a farm or shipment covered by the health certificate includes salmonids.
- Viral hemorrhagic septicemia (VHS) if a farm or shipment covered by the health certificate includes any of the following fish or fish eggs of a species that the federal bureau has found to be susceptible to viral hemorrhagic septicemia (VHS):
  - Fish or fish eggs collected from a wild source* within the 12 month period immediately preceding the shipment.
  - Fish or fish eggs kept at a fish farm that received fish or fish eggs of any species collected from a wild source within the 12 month period immediately preceding the distribution date.

Laboratory tests required for farm to farm movement of any live fish or fish eggs in Wisconsin [ATCP 10.64] (see Exception below):

- Viral hemorrhagic septicemia (VHS) if a farm or shipment covered by the health certificate includes any of the following fish or fish eggs of a species that the federal bureau has found to be susceptible to viral hemorrhagic septicemia (VHS):
  - Fish or fish eggs collected from a wild source within the 12 month period immediately preceding the shipment.
  - Fish or fish eggs kept at a fish farm that received fish or fish eggs of any species collected from a wild source within the 12 month period immediately preceding the distribution date.

EXCEPTIONS [ATCP 10.64(3)]:

- Fish or fish eggs moved between fish farms registered under s. ATCP 10.61 by the same fish farm operator, if the operator keeps a complete record of the movement under s. ATCP 10.61(10). This exemption does not apply to the movement of fish or fish eggs from a type 3 fish farm to a type 1 or type 2 fish farm, or, the movement of fish or fish eggs between fish farms that are required under s. ATCP 10.61(5m) to be medically separated.
- Fish or fish eggs moved to a food processing plant, retail food establishment or restaurant for processing or direct sale consumers, provided that the receiving entity does not hold any of the fish or fish eggs for more than 30 days prior to slaughter or direct sale to consumers, commingle the fish or fish eggs with fish or fish eggs that may be used for any other purpose, sell or distribute unprocessed fish or fish eggs to consumers at any place other than the food processing plant, retail food establishment or restaurant at which the entity first receives them, discharge to waters of the state any untreated water used to hold or process any of the fish or fish eggs, and dispose of any dead fish, dead fish eggs or fish offal except by rendering, composting, municipal solid waste disposal, or other means approved by the department.

Laboratory Tests required for wild source live fish or fish eggs distributed for use as bait [ATCP 10.645]:

- Viral hemorrhagic septicemia (VHS) if a farm or shipment covered by the health certificate includes any of the following fish or fish eggs of a species that the federal bureau has found to be susceptible to viral hemorrhagic septicemia (VHS):
  - Fish or fish eggs collected from a wild source within the 12 month period immediately preceding the shipment.
  - Fish or fish eggs kept at a fish farm that received fish or fish eggs of any species collected from a wild source within the 12 month period immediately preceding the distribution date.

A fish health certificate is not required for the movement of live fish or fish eggs between fish farms that are registered by the same registrant provided that the registrant keeps complete records of the movement.

APPENDIX F

Fish Inspection Report

University of Arkansas at Pine Bluff
Fish Health Inspection Laboratory at Lonoke

December 7, 2016

Sample source: [redacted]

Sample Description: A farm-level sample consisting of 60 fathead minnows (*Pimephales promelas*), 60 golden shiners (*Notemigonus crysoleucas*), 60 goldfish (*Carassius auratus*), 60 bluegill (*Lepomis macrochirus*), 60 bluegill hybrid (*Lepomis macrochirus* X *Lepomis cyanellus*), and 60 redear sunfish (*Lepomis microlophus)* was collected from across the farm under the supervision of an APHIS Certified Veterinarian (Dr. Marilynn Baeyens, DVM, 8620 Hwy 107, Sherwood, AR 72120, 1-501-993-2065). Fish were submitted live and on ice to the laboratory on November 8, 2016. **Case ID# LN16-73.**

Inspection Performed: Spleen and trunk kidney tissue samples from all fish of each species were inoculated on FHM and BF-2 cell lines, including a blind passage, and examined for fish viruses including SVCV, VHSV, IPNV, and IHNV according to inspection protocols based on OIE, APHIS, and/or FHS-AFS Bluebook Standards and/or Northeast Fish Health Committee Guidelines. Trunk kidneys were cultured on BHI agar for bacteria. All fish were observed for signs of *Heterosporis* spp.

Results: All of the fish were negative for SVCV, IHNV, VHSV, and IPNV. No primary bacterial pathogens were isolated. No signs of *Heterosporis* spp. were observed.

Additional Notes: [redacted] Fisheries has been inspected semi-annually for viruses (at least 150 fish twice per year) since 2002. No pathogens reportable to the OIE have ever been detected in any regulatory or clinical sample submitted by this farm. The farm is certified free of important ANS species (including zebra, quagga, and Conrad's false mussels, and New Zealand mud snails) by the Arkansas Agriculture Department.

Inspected by:

Anita M. Kelly

Anita M. Kelly, PhD.
Associate Director/Extension Fish Health Specialist
AFS/FHS Fish Health Inspector
UAPB, Fish Health Inspection Laboratory at Lonoke
Phone: 501-676-3124; Email: kellya@uapb.edu

Aquaculture/Fisheries Center
University of Arkansas at Pine Bluff

APPENDIX F cont.

Fish Inspection Report

Diagnostic Testing performed according to APHIS-Approved Protocols
University of Arkansas at Pine Bluff Fish Health Inspection Laboratory

Case ID #: LN16-73
Farm [redacted]
Contact:
Address:
Phone:

Sample Collector: Marilynn Baeyens, DVM
Address: 8620 Hwy 107, Sherwood, AR 72120
Phone: (501) 993-2065

APHIS-AVIC: Becky Brewer, DVM
Address: 1200 Cherry Brook Dr., STE 300, Little Rock, AR 72211
Phone: (501) 224-9515

Raised UAPB Seal

Sampling Date: November 8, 2016; Inspection Report Date: December 7, 2016

Tests Performed: **_x_ VHSV** **_x_ IPNV** **_x_ SVCV** **_x_ IHNV** **_x_ KHV**

Sample Description: **___x___ Farm-level Inspection** **_____ Lot Inspection**

Number	Common name	Scientific name	Size (inches)	Lot ID*
60	Fathead Minnows	*Pimephales promelas*	1.5-2.5	
60	Goldfish	*Carassius auratus*	2.5-3.5	
60	Golden Shiners	*Notemigonus crysoleucas*	2.5-3.5	
60	Bluegill	*Lepomis macrochirus*	2-3.5	
60	Bluegill X green sunfish hybrid	*Lepomis macrochirus* X *Lepomis cyanellus*	2-3.5	
60	Redear sunfish	*Lepomis microlophus*	1-2.5	

*Lot inspections only. Not applicable to farm-level inspections.

Results:

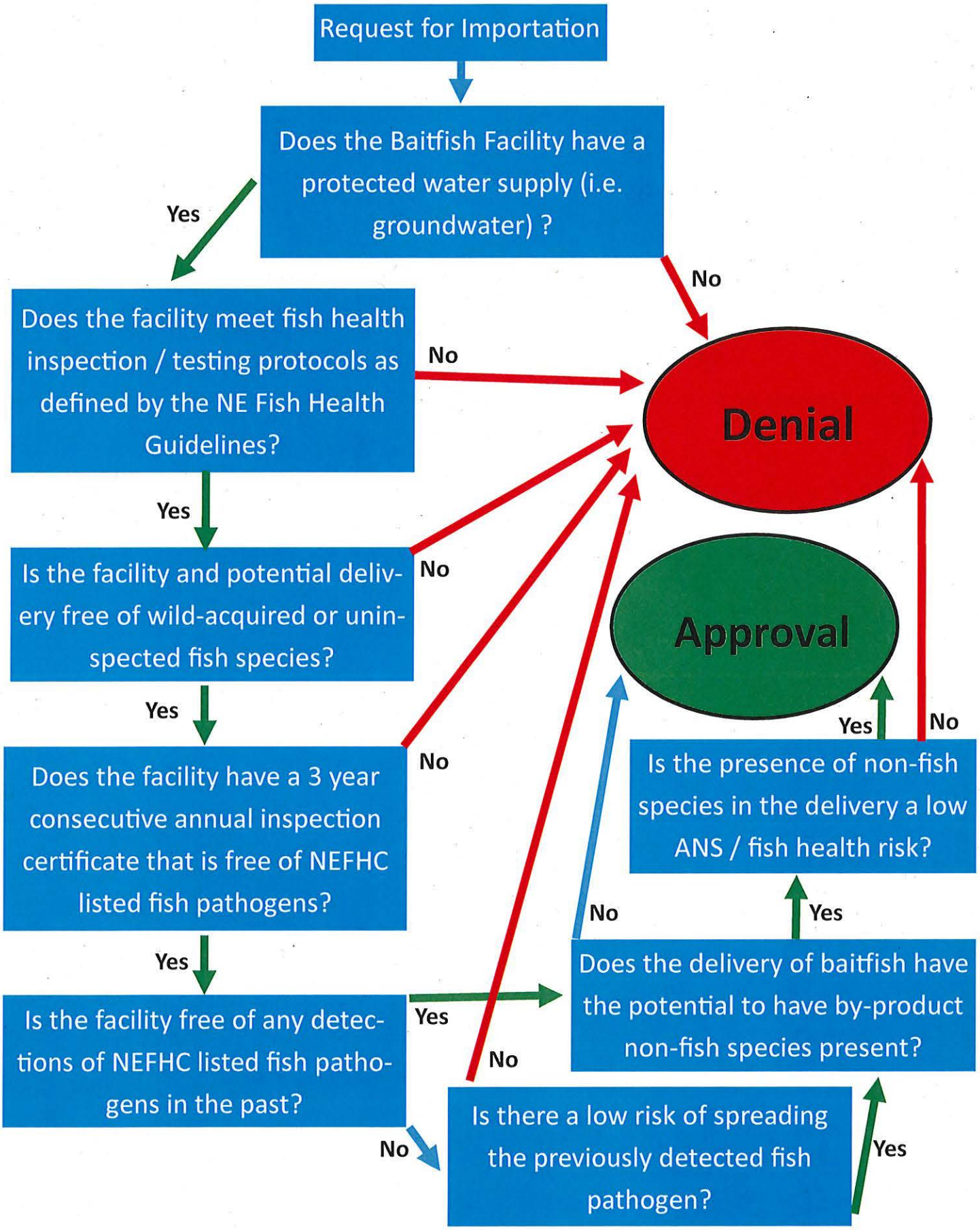
No cytopathic effects consistent with SVCV, IHNV, VHSV, or IPNV were observed in viral cultures using OIE, AFS-FHS Bluebook, and APHIS approved protocols. Goldfish were negative for KHV by real-time PCR.

Inspected by:

Anita M. Kelly

Anita M. Kelly, PhD.
Associate Director/Extension Fish Health Specialist
AFS/FHS Fish Health Inspector
UAPB, Fish Health Inspection Laboratory at Lonoke
Phone: 501-676-3124; Email: kellya@uapb.edu

Baitfish Importation Decision Making Process



APPENDIX H

Aquatic Invasive Species in Arkansas

Approach to Prioritization of AIS in Arkansas for 1. control, 2. containment and 3. prevention.

1. Control Ranking for Species Already Found in Arkansas

High Control Rank *(11 species):* Giant lyngbya, water lettuce, Asian tiger mosquito, zebra mussels, silver carp, Asian clam, white perch, Eurasian watermilfoil, hydrilla, water hyacinth and alligatorweed.

Medium Control Rank *(9 species):* Catfish trematode, common reed, Brazilian waterweed, purple loosesrife, beaver, nutria, northern snakehead, bighead carp and yellow bass.

Low Control Rank *(12 species):* Didymo, gapped ringed crayfish, yellow perch, American white pelican, double-crested cormorant, amphibian chytrid fungus, Uruguayan primrose, duck lettuce, infectious pancreatic necrosis, parasitic copepods, black carp and curly-leaf pondweed.

2. Containment Ranking for Species Already Found in Arkansas

High Containment Rank *(12 species):* Giant lyngbya, water lettuce, Asian tiger mosquito, zebra mussels, Asian clam, Eurasian watermilfoil, hydrilla, water hyacinth, alligatorweed, catfish trematode, didymo and gapped ringed crayfish.

Medium Containment Rank *(8 species):* Silver carp, white perch, common reed, northern snakehead, bighead carp, yellow bass, amphibian chytrid fungus and parasitic copepods.

Low Containment Rank *(12 species):* Brazilian waterweed, purple loosestrife, beaver, nutria, yellow perch, duck lettuce, infectious pancreatic necrosis, black carp and curly-leaf pondweed.

3. Prevention Ranking for Species Not Yet Found in Arkansas

High Prevention Rank *(12 species):* Rusty crayfish, yabby, white spot syndrome virus, Chinese mittencrab, channeled apple snail, round goby, salamander iridoviris, viral hemorrhagic septicemia, Eurasian ruffe, whirling disease, giant salvinia and big-ear radix.

Medium Prevention Rank *(9 species):* Golden algae, quagga mussel, alewife & blueback herring, muscle microsporean, spring viremia of carp virus, Taura syndrome viris, New Zealand mudsnail, red-rim melania and snakeheads.

Low Prevention Rank *(10 species):* Koi herpes viris, Chinese mystery snail, ghost Ramshorn snail, quilted melania, Australian red claw crayfish, infectious hematopoetic necrosis, roundleaf toothcup, Everglades crayfish, smooth marron and sticklebacks.

Each of the invasive animals, plants, and pathogens (listed above) were reviewed in the AR ANS MP (2013) beginning on page 52.

APPENDIX I

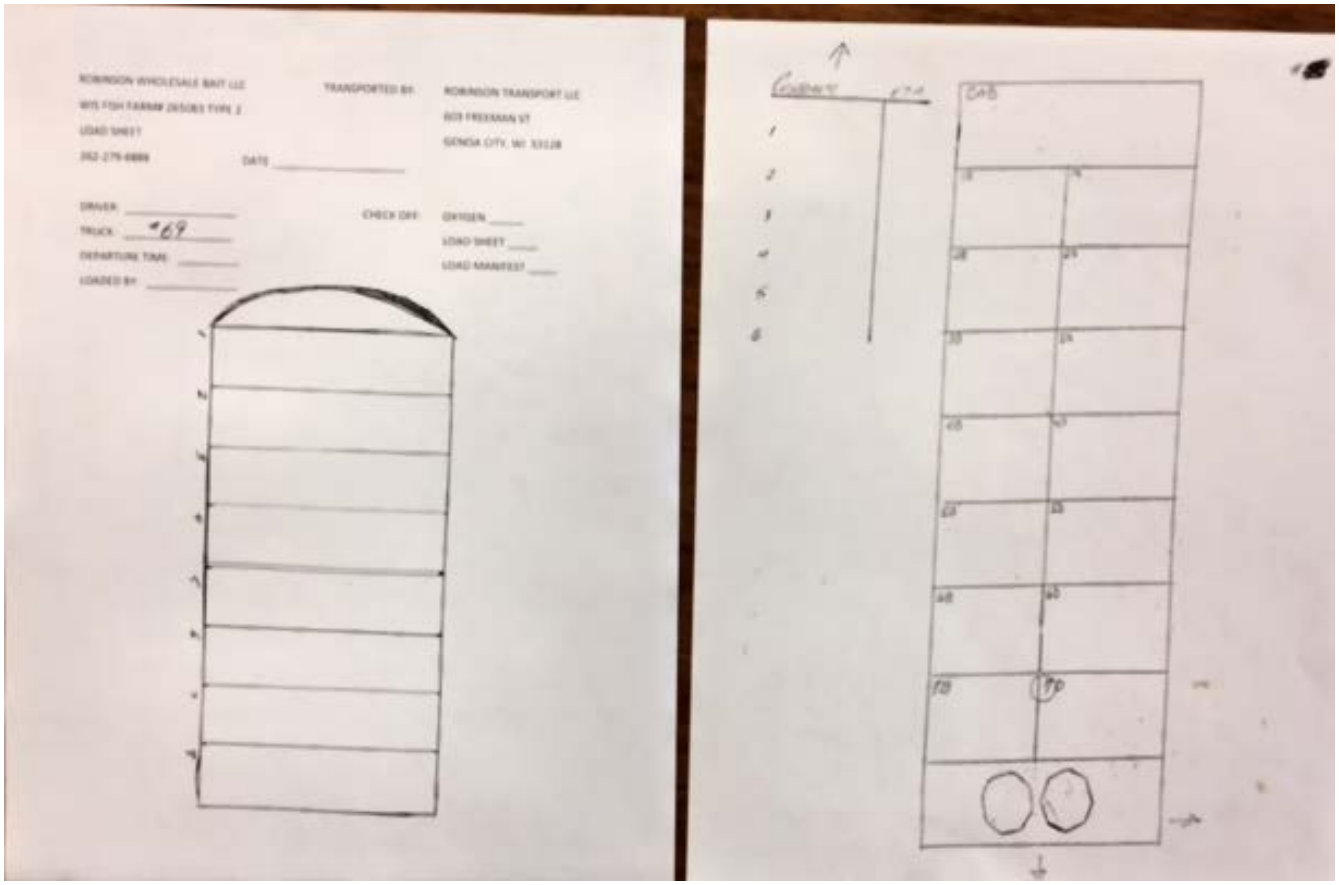
5:09 AM
01/15/18
Accrual Basis

ROBINSON WHOLESALE BAIT LLC
DRIVER'S MANIFEST
MARCH 29

Date	Num	Memo	Name	Qty	Sales Price	Amount
Inventory						
Asst Minnows (MINNOWS)						
FH010 (SMALL FATHEADS)						
01/15/2018	57758	SMALL FAT...	MICHIGAN CITY W...			
01/15/2018	57759	SMALL FAT...	WENDELL'S			
Total FH010 (SMALL FATHEADS)						
GS030 (MD GOLDEN SHINER/ROACH)						
01/15/2018	57758	MD GOLDEN...	MICHIGAN CITY W...			
Total GS030 (MD GOLDEN SHINER/ROACH)						
GS040 (LG GOLDEN SHINER/ROACH)						
01/15/2018	57758	LG GOLDEN...	MICHIGAN CITY W...			
01/15/2018	57759	LG GOLDEN...	WENDELL'S			
01/15/2018	57760	LG GOLDEN...	BUC'S AQUAFARM...			
Total GS040 (LG GOLDEN SHINER/ROACH)						
RR010 (SM ROSY REDS)						
01/15/2018	57758	SM ROSY R...	MICHIGAN CITY W...			
01/15/2018	57759	SM ROSY R...	WENDELL'S			
Total RR010 (SM ROSY REDS)						
SU-DECOY (DECOY SUCKERS PER POUND)						
01/15/2018	57760	DECOY SUC...	BUC'S AQUAFARM...			
Total SU-DECOY (DECOY SUCKERS PER POUND)						
SU020 (MD SUCKERS 4"-7")						
01/15/2018	57758	MD SUCKER...	MICHIGAN CITY W...			
01/15/2018	57759	MD SUCKER...	WENDELL'S			
01/15/2018	57760	MD SUCKER...	BUC'S AQUAFARM...			
Total SU020 (MD SUCKERS 4"-7")						
Total Asst Minnows (MINNOWS)						
BULK WORMS						
WWB1000 (BULK WAX WORMS/10,000/TUB MINIMUM)						
01/15/2018	57760	BULK WAX ...	BUC'S AQUAFARM...			
Total WWB1000 (BULK WAX WORMS/10,000/TUB MINIMUM)						
Total BULK WORMS						
Other Bait Items						
270-F-12-SG-4 (FINE MESH BAIT DEALER NET 12" DEEP 48"						
01/15/2018	57760	FINE MESH ...	BUC'S AQUAFARM...			
Total 270-F-12-SG-4 (FINE MESH BAIT DEALER NET 12" D...						
PK16BRY (FABRI-KAL PLASTIC 16 OZ CUP 500/CS)						
01/15/2018	57758	FABRI-KAL ...	MICHIGAN CITY W...			
Total PK16BRY (FABRI-KAL PLASTIC 16 OZ CUP 500/CS)						
PKLIDVB (FABRI-KAL PLASTIC LID FOR 8,12,16 OZ CUPS 5(						
01/15/2018	57758	FABRI-KAL ...	MICHIGAN CITY W...			
Total PKLIDVB (FABRI-KAL PLASTIC LID FOR 8,12,16 OZ C...						
Total Other Bait Items						
Total Inventory						

APPENDIX J

This is an example of minnow hauling truck load layout with each compartment numbered.



APPENDIX K

Minnow Import Risk Report Process

1) Legislation signed on May 30, 2017 directing the DNR to submit a report to the Legislature on the risks of importing golden shiners into the state from Arkansas.
2) DNR assembles project team (summer 2017).
3) DNR decides to contract report on minnow import to third party. Discusses report content with University of Minnesota faculty and other risk assessment experts (summer 2017)
4) Discussed project with potentially qualified third parties. DNR developed a request for proposals (RFP) in consultation with University of Minnesota risk assessment experts Dr. Rob Venette and Dr. Kristen Nelson.
5) The RFP was posted for bid in fall 2017. Three DNR personnel and one University of Minnesota faculty were identified to score responses to the RFP.
6) The contract was awarded to Jeff Gunderson in late fall 2017.
7) DNR project managers met bi-weekly with Mr. Gunderson. In addition to project managers, check in meetings included additional DNR FAW and EWR staff, DNR enforcement, and University of Minnesota staff as available.
8) Initial draft submitted to DNR in early January 2018. Draft reviewed by MN DNR staff (FAW, EWR, Enforcement), University of Minnesota (both risk assessment and subject matter experts), and persons interviewed for the report.
9) The DNR amended Mr. Gunderson's contract to provide additional time to work on the report.
10) A second draft submitted to the MN DNR and others for review in late January 2018.
11) Mr. Gunderson delivered a final report to the DNR on February 8, 2018, as specified by the amended contract.